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LEAD ARSENATES, STONE FRUITS, AND THE WEATHER[1]

By GEO. P. GRAY

The appearance of an unusual number of canker worms in the prune and apricot orchards of the Santa Clara Valley (Cal.) in the spring of 1915 caused a great many of the orchardists of that section to make one or two sprayings of lead arsenate in order to prevent defoliation of the trees. The worms were well controlled within a short time, but some two or three weeks after the application of the poison, it was noticed that the trees began shedding their foliage. The injured leaves were specked with brown spots, each speck being dead leaf tissue. (See pl. 16.) Some of the fruit was also injured in the same way. The defoliation in some of the orchards amounted to perhaps 50 per cent. while in others the injury was not as serious. Defoliation and fruit dropping was quite general, however, wherever lead arsenate had been applied for the canker worms.

It so happened that practically all of the lead arsenate used on prunes and apricots in the vicinity was purchased from a single firm. Some of the orchardists had never before been obliged to use an arsenical and so the use of arsenicals in general was condemned. Others thought that they had been supplied with a poor grade of arsenical, and threatened law-suits. The office of the County Horticultural Commissioner was besieged with inquiries as to the cause of the trouble. The situation was so unusual that the Commissioner (Mr. E. L. Morris) called upon the Insecticide and Fungicide Laboratory of the Agricultural Experiment Station for assistance in the

[1] Presented before the State Fruit Growers' Convention, Stanford University, July 26–31, 1915.

solution of the problem. The writer made two trips to the valley and spent several days in company with Mr. Morris visiting the injured orchards, interviewing the owners and securing data upon which to base conclusions. Five samples of lead arsenate were secured from different orchards which had suffered from spray injury. The matter was gone over quite carefully with Mr. Morris; representatives of two important manufacturers of lead arsenate were interviewed; and the samples were examined by the writer. As a result of the investigation, certain conclusions have been made and will be submitted later on in the paper.

In order that the discussion of the case may be better understood, it seems well to present some theories of spray injury, to describe the commercial types of lead arsenate, and to point out the recognized susceptibility of stone fruits to spray injury.

Theory of Spray Injury

For injury to result from the application of a spray, it is necessary that the material be absorbed in some way. It seems quite essential that the material should be in solution before absorption can take place. At least, there is no evidence that a solid can enter the tissue of plants or animals to cause lesions of any sort. The modern practice of applying arsenicals to foliage is based upon the proper combination of the poison in a form which is insoluble in water in order to prevent its entering plant tissue and causing damage. It is generally recognized that the damage which is sometimes caused by arsenicals is due to the part of the arsenical which is soluble in water and which may thus enter the tissue of the plant to disturb its functions.

Arsenic has been combined with many substances to find a combination which is the least soluble and the least affected by weather conditions, and to find a combination that is the most suitable for use in other ways. Of all the combinations thus far tried, a chemical combination of arsenic with lead seems to most fully meet the above conditions. At present, there are two types of lead arsenate upon the market, each having its own place in spray practice.

Types of Commercial Lead Arsenate

Acid Lead Arsenate; Lead Hydrogen Arsenate (often Labeled "Standard".)—In an investigation to find the most suitable form in which an arsenical could be applied to foliage, Mr. F. C. Moulton,[1] chemist for the Massachusetts Gypsy Moth Commission, selected lead arsenate as the combination most suitable for use in his work. This arsenical offered so many advantages over other arsenicals in use

[1] Mass. Bd. Agr. Rept., 41, p. 282 (1894).

Prune leaves injured by the decomposition of acid lead arsenate during a succession of light misty rains. Taken from the orchard of Mr. F. J. Shepherd, Edenvale California, May, 1915. (Natural size.)

previous to his work, that it is rapidly supplanting all other forms of arsenicals for use on foliage. This arsenical may be prepared by mixing in proper proportions a soluble salt of lead, usually lead nitrate or lead acetate, and a soluble salt of arsenic acid, usually sodium arsenate. The process has been perfected and cheapened by commercial manufacturers so that the use of these soluble salts, as raw materials, has been largely discontinued. At present, many of the manufacturers prepare commercial lead arsenate paste from lead oxide (litharge) and arsenic acid. This process greatly cheapens and simplifies the manufacture of the paste in ways which need not be discussed in this paper. As ordinarily made, there results a compound which may be spoken of in chemical language as an acid lead arsenate or possibly a mixture of this and neutral or basic lead arsenate. It was found that lead arsenate produced in this way gave very uniform and satisfactory results in most cases for the control of leaf-eating insects.

Basic Lead Arsenate (usually Labeled "Tri-Plumbic" or "Neutral").—The lead arsenate produced in the usual way, however, was found to produce very serious foliage injury under certain climatic conditions which prevail in the Pajaro Valley, the principal apple growing section of California. In the spring of 1903, field and laboratory work was commenced by the Entomological Division of the University of California to find a more suitable arsenical or to modify the known methods of preparation of lead arsenate so that it could be used without injury under the conditions prevailing in the valley.[1] The field work was conducted by Mr. W. H. Volck and Mr. E. E. Luther, students in the College of Agriculture. After numerous experiments, the process of preparation was so modified that a new type of lead arsenate was produced which could be used with safety upon the apple trees in that section. The modified process and some theories of foliage injury are discussed in the publication previously referred to. This new process lead arsenate was at first believed to be what may be termed a neutral lead arsenate. Our knowledge of the chemistry of lead arsenates is still very imperfect, but later investigations seem to indicate that the material produced in the manner described by Volck[2] may more properly be referred to as basic lead arsenate.

Comparison of the Two Types.—To take up a full discussion of the composition of the two types mentioned would be of too technical a nature for presentation in a paper of this kind. The acid type is very susceptible to the action of other chemicals and is more or less

[1] Volck, W. H., Science, N. S., vol. XXXIII, No. 857, pp. 866–870 (1911).
[2] *Op. cit.*

dissolved by chemicals of an alkaline nature which are commonly found in many spray materials. This property distinguishes the acid type of lead arsenate from the basic. The latter is not easily affected by alkaline chemicals and is a much more stable chemical compound under neutral or alkaline conditions. It is not easily made soluble by ordinary influences. A theory was advanced by Volck that the acid type of lead arsenate was decomposed by the small amounts of ammonia (alkaline) which are sometimes present in the atmosphere, producing a soluble form of arsenic. Under the conditions prevailing in the Pajaro Valley, there was present on the foliage enough moisture to dissolve the soluble arsenic, thus formed, and make possible its absorption by the foliage. The basic lead arsenate, on the other hand, is absolutely insoluble in ammonia and soluble arsenic cannot be formed in this manner. Whether this theory is correct or not has not been fully confirmed by other experimenters, but the fact remains, however, that the basic type is the safer arsenical to use upon foliage in the humid coast regions. The basic type is practically the only arsenical which may be safely mixed with any of the other spray materials as a combination spray. This has been fully tested out in the Insecticide and Fungicide Laboratory and has been found to be much more suitable when alkalies of any sort are mixed with it. The acid type is a stronger poison, however, and its action upon the insects is much more rapid. The basic type contains much less arsenic to the pound and a much longer time is required to poison insects.

The stronger and quicker acting acid lead arsenate is therefore the one to be naturally selected for use upon foliage which is not peculiarly susceptible to spray injury and where the weather conditions are not apt to cause its decomposition, that is, in the more arid regions away from the coast. The basic type should be used whenever an arsenical is to be mixed with any other material (with one or two exceptions) as a combination spray. The *basic type* is the one to be recommended for use in the humid coast regions and upon *all stone fruits* or any others which are especially susceptible to spray injury.

Susceptibility of Stone Fruits to Spray Injury

It is a well-known fact that the foliage of all stone fruits is peculiarly susceptible to injury from many kinds of sprays. This fact has been noted in respect to the use of arsenicals and the California Agricultural Experiment Station has advised that the basic type of lead arsenate should be the only arsenical applied to stone fruits. The wisdom of this advice has been doubted by a great many and the cause of the doubt is not difficult to find. If the weather is favorable, the acid type of lead arsenate usually may be applied with impunity. In

fact, this has been done in the Santa Clara Valley for a number of years with only occasional bad effects. This year, however (1915), has shown that this procedure is not a safe one and some other way must be chosen if the growers do not wish to take the consequences of defoliation and fruit drop due to the effect of unfavorable weather conditions upon acid lead arsenate.

The weather conditions that are believed to favor the decomposition of acid lead arsenate are a succession of light rains extending over a period of several days, continual foggy or damp "muggy" weather, and more or less warmth. A heavy rain is not as serious as a mist, for if there is a decomposition of the arsenate, a rain sufficient to drip from the leaves may wash off the soluble arsenic before its absorption.

Weather Record for the Period of Spray Injury

The following weather record covering the period of spray injury has been kindly furnished by Mr. W. H. Ward of Morgan Hill, Cal., who was one of the orchardists to suffer quite seriously from spray injury.

The rain records are taken in the morning about 7 a. m. and are as follows:

April 20	.66 inch
April 26	.27 inch
April 27	.14 inch
April 28	.11 inch
April 29	.11 inch
May 1	.11 inch
May 3	.38 inch
May 4	.97 inch
May 9	.20 inch
May 10	.22 inch
May 11	.16 inch
May 13	.18 inch
May 16	.31 inch
May 23	.07 inch

The spraying was done on the Ward ranch on April 19 and on the afternoon of April 20. The weather was damp when the spraying was done the first day and it rained the night following. The spraying was finished the next afternoon.

The amount of acid lead arsenate used was from 4 to 4¼ lbs. to 100 gallons of water. This was about the amount used by the other growers. The injury was noticed about two weeks after the application of the spray.

Theories Confirmed by the Investigation

As previously noted, five samples of lead arsenate paste were collected during the progress of the investigation. These samples were

taken from parts of kegs of the paste which were said to have been left over from the previous sprayings which had caused the injury. The labels were in some cases obscure, but from the information gathered from the labels, from statements by the growers and by the dealer supplying the arsenicals, it seems that the five samples represented at least three different brands of lead arsenate. Examination revealed the fact that they were all of the acid type. None of them contained an unusual or dangerous amount of soluble arsenic. In fact, one of the samples showed only a trace of soluble arsenic. The samples were in all respects normal as far as could be determined. Furthermore, the samples representing three different brands, it *seems improbable that all three of the companies should happen to produce a poor grade of material at the same time.*

The orchard of Mr. August Nielson in the Evergreen district near San José was visited, which consisted principally of apricots. There were, however, three rows of apple trees running across this orchard. The whole orchard was sprayed with acid lead arsenate on April 13. Five pounds of lead arsenate were used to the 100 gallons. Foliage injury and dropping of leaves and fruit was noticed before the first of May following. The whole orchard was uniformly sprayed with the strength of arsenical given above. It was noticed that spray injury occurred on the foliage of all of the apricot trees while no injury could be detected upon the foliage of the apple trees. The point brought out by the above observation is that the stone fruits only were injured, that the apple trees were uninjured, and that the lead arsenate used could not be considered of poor grade.

The adjacent orchard of Mr. R. Chaboya was also visited. This orchard consisted almost entirely of prune trees. Only a part of the trees in this orchard were sprayed, some of which were sprayed twice and some once. It was observed that the most defoliation resulted where two sprayings had been made. Wherever the trees had been sprayed, foliage injury was apparent. No foliage injury was observed upon the trees which had not been sprayed. This observation, as well as similar observations on other orchards, leaves no room for doubt that the injury had been caused by the spray.

Observations were also made on a prune orchard owned by Mr. F. J. Shepherd, Edenvale. Only a part of the trees had been sprayed. Those sprayed uniformly showed injury, while those not sprayed showed no injury. This observation confirmed the above. Many other orchards were visited. To record the observations made would largely be a repetition of the above. It was noticed, however, in this connection that occasionally a pear or an apple tree had been sprayed with the arsenical and in no instance could injury be detected, while

in every case where stone fruits had been sprayed, with acid lead arsenate, more or less injury was apparent.

Summary

According to the observations made of stone fruits to which acid lead arsenate had been applied during the month of April, 1915, they showed injury to a greater or less extent. Pome fruits which were sprayed under the same conditions causing the injury as above noted showed no injury. Examination of five samples of lead arsenate collected during the investigation represented three different brands. In no case did the analysis reveal the presence of unusual quantities of water-soluble arsenic. The samples were all good grades of acid lead arsenate. According to weather records and to the testimonies of the growers, a period of damp, misty weather prevailed during and after the application of the lead arsenate causing the spray injury. It seems reasonable to conclude:

1. The acid type of lead arsenate, often labeled "standard," is unsafe to use on the foliage of stone fruits except under favorable weather conditions.

2. According to weather reports, it appears that during the spring of this year (1915) (particularly during the month of April) unusually unfavorable weather conditions prevailed in the Santa Clara Valley, Cal.

3. The foliage injury in the orchards of the Santa Clara Valley this spring was due to the decomposition of acid lead arsenate by the weather.

4. According to previous experience and in accordance with previous recommendations of the University, the basic type of lead arsenate (usually labeled "tri-plumbic" or "neutral") is a safer arsenical to use on stone fruits and is not decomposed by unfavorable weather conditions. This is a slower acting poison, however, than the acid type and would not be as effective unless applied when the canker worms are very young.

Recommendations

In looking up the recommendations of entomologists and taking into consideration the experiences previously noted, it appears that there is a choice of three procedures for the control of canker worms:

1. Banding of trees has been found to give satisfactory results. Essig[1] may be cited as authority for recommending "tree tanglefoot" for the control of both spring and fall canker worms.

2. The acid type of lead arsenate may be successfully used on stone

[1] Essig, E. O., Injurious and Beneficial Insects of California, pp. 417 and 415.

fruits for the control of canker worms *provided the weather conditions are favorable.* It is *not recommended,* however, for general practice as there can be no guarantee of what the weather may be after the application of the arsenical.

3. It is *very strongly recommended,* when necessary to use an arsenical upon stone fruits, that the *basic type of lead arsenate be used exclusively.* In order that this slower acting poison may be effective, it will be necessary to keep a close watch of the orchards and make the application while the worms are very young.

WILD VEGETATION AS A SOURCE OF CURLY-TOP INFECTION OF SUGAR BEETS[1]

By P. A. Boncquet, *Bacteriologist, Collaborator,*[2] and C. F. Stahl, *Scientific Assistant, Truck Crop and Stored Product Insect Investigations, Bureau of Entomology*

The curly-top condition of sugar beets has for some time been a subject of investigation by phytopathologists, but on account of the failure to discover a specific organism responsible for the physiological injury to the plant, the problem has been peculiarly baffling. Although the connection of the jassid leafhopper, *Eutettix tenella* Baker, with the disturbance has been definitely established, conclusive evidence has not previously been available as to the exact nature of the trouble, or as to the part played by the leafhopper in the dissemination of the virus. It is believed that the results secured as herein related may be of assistance in establishing in part the nature of the disorder, the identity of its probable alternate hosts and the conditions governing its somewhat periodical or sporadic appearance in beet fields.

A brief review of the investigations leading to the experiments which will be mentioned may serve to emphasize the significance of the results obtained.

The connection of *Eutettix tenella,* known both as the sugar-beet leafhopper and the curly-top leafhopper, with the condition was first definitely established in 1909.[3] Soon afterwards it was found that a single leafhopper in any stage was capable of producing the condition

[1] Published by permission of the Honorable Secretary of Agriculture.

[2] Since this article was first presented for publication, Doctor Boncquet has been absent in Argentina. He has not, therefore, had the opportunity of approving some of the corrections in the manuscript.

[3] Ball, E. D. The Leafhoppers of the Sugar Beet and Their Relation to the "Curly-leaf" Condition. U. S. Dept. Agr. Bur. Ent. Bul. 66, pt. 4, p. 33–52, pl. 1–4, 1909.

by feeding on a healthy beet for two minutes.[1] In these experiments it was further demonstrated that insects reared from the egg stage on healthy beets were unable to produce the characteristic condition

The curly-top leafhopper feeds on a number of species of wild plants, in addition to its attacks on the sugar beet. Specimens collected from wild host plants were accordingly tested on healthy beets, but without bringing about the curly-top condition.[2] They acquired the ability to cause the characteristic symptoms of the condition by feeding on affected beets. This ability was lost in from 15 to 35 days if the insects were transferred daily to healthy beets. A period of incubation, dependent on temperature, and lasting at least two days was required.[3]

The apparently sporadic occurrence of curly-top outbreaks in remote isolated desert regions, where beets had never before been grown suggested either that the leafhopper was capable of migrating to great distances, or that the virulent factor resided in other food plants than the beet, and was perpetuated either in a virulent form or in a symbiotic relation by these plants. The first being untenable, the second suggestion was investigated, the results obtained to the present time apparently justifying this paper.

Recent Investigations

Early in the fall of 1915 it was observed that many mallow plants (*Malva rotundifolia*) (Pl. 17, fig. 1) growing in the vicinity of beets affected with curly-top showed signs of abnormal development (Pl. 18, fig. 1). The plants were dwarfed and the leaves were irregularly contorted, the growing bud stunted, showing only two or three extremely small leaves, indicating a widespread disturbance in growth. Several of these abnormal plants were examined microscopically, revealing internal lesions similar to those observed in beets affected with curly-top. The phlœm was injured not only in the stem and roots but even in the extreme parts of the leaves. The medullary rays of the stem were also attacked and in some places showed total disintegration.

[1] Smith, R. E., and Boncquet, P. A. New Light on Curly-top of the Sugar Beet. *In* Phytopathology, vol. 5, p. 103, 1915. Connection of a Bacterial Organism with Curly-leaf of the Sugar Beet. *In* Phytopathology, vol. 5, p. 335, 1915.

[2] Boncquet, P. A. *Bacillus morulans*, n. sp. Thesis presented for degree of Doctor of Philosophy at the University of California. University Documents, 1915. The Comparative Effect upon Sugar Beets of *Eutettix tenella* Baker from Wild. Plants and from Curly-leaf Beets (with W. J. Hartung). *In* Phytopathology, vol. 5, p. 348, 1915.

[3] Smith, R. E., and Boncquet, P. A. New Light on Curly-top of the Sugar Beet. *In* Phytopathology, vol. 5, p. 103, 1915. Connection of a Bacterial Organism with Curly-leaf of the Sugar Beet. *In* Phytopathology, vol. 5, p. 335, 1915.

Special staining methods demonstrated that organisms[1] similar to those previously found in affected beets were present. This striking resemblance suggested the possibility of the mallow being an alternate host in beet infection, and experiments were started to determine the relationship. In order to verify these assumptions two different methods were devised which, if successful, would furnish unquestionable proof. These methods were only the consequence of previous results obtained during investigations relating to virulent and non-virulent insects.

Experiments

In the first set of experiments two factors were most essential for success: (1) Insects must be used which were known to be non-virulent; and (2) beet plants must be used which had been grown under cover and were known to be healthy. Mallow plants (*Malva rotundifolia*) which showed signs of some disturbance (Pl. 18, fig. 1) were selected, growing in the field which contained a large number of beets affected with the characteristic curly-top. A microscopic examination disclosed internal disorders similar to those previously mentioned. Insects which had been kept under close observation for more than six months and which were known to be non-virulent were selected and placed on the mallow in small leaf cages. After several days these insects were removed and placed on healthy beet plants in specially constructed cages. These beet plants were kept under close observation and the first symptoms of curly-top noted (Pl. 18, fig. 2). One insect was placed on an affected beet instead of a mallow plant and was used as a check so that it could be ascertained whether or not the condition would develop normally during the fall season of the year. Table I shows the results of these experiments.

Table I.—Experiments in the Placing of Non-Virulent Specimens of Eutettix tenella on Affected Mallow Plants and Their Subsequent Transference to Healthy Beet Plants, Resulting in Curly-top Infection

Exp. No.	Date Placed on Mallow	Date Transferred to Healthy Beet	Date of First Symptoms of Curly-top	No. of Insects Used
1	Oct. 22, 1915	Oct. 27, 1915	Dec. 17, 1915	1
2	Oct. 27, 1915	Nov. 5, 1915	Jan. 10, 1916	1
3	Oct. 27, 1915	Nov. 5, 1915	Remained healthy	1
4	Oct. 27, 1915	Nov. 5, 1915	Nov. 29, 1915	1
5	Oct. 27, 1915	Nov. 5, 1915	Dec. 22, 1915	1
(Check on affected beet plant)				

[1] Boncquet, P. A. *Bacillus morulans* n. sp. Thesis presented for degree of Doctor of Philosophy at the University of California. University Documents, 1915. The Comparative Effect upon Sugar Beets of *Eutettix tenella* Baker from Wild Plants and From Curly-leaf Beets (with W. J. Hartung). *In* Phytopathology, vol. 5, p. 348, 1915.

After remaining on the healthy beets for about two weeks all insects employed in the foregoing experiment were transferred to other healthy beets and the results were duplicated. Actual dates were not recorded, but all cases developed somewhat more rapidly than usual, due to the fact that the plants were kept in the greenhouse where the temperature was much higher. It will be noted from these results that the time required for the symptoms to develop was quite long, in fact much longer than was the case during the preceding summer in experiments with other phases of the condition. This unusual length of time was due to the unfavorable weather conditions prevailing later. The days were cold and cloudy and growth of the beets was practically at a standstill. It has been observed in these and other experiments that the symptoms of the condition do not appear unless the plant is growing. Two causes may be responsible for the fact that No. 3 did not show curly-top symptoms. Either the mallow was not affected, or the weather and the conditions in the beet plant were such that the organism was killed before it had a chance to develop. This assumption was more strikingly borne out in the following results, obtained from similar experiments at a later date. December 1, 1915, one of the same mallow plants was selected and six non-virulent insects placed upon it in a lantern globe. After a period of seven days they were removed and placed singly on healthy beets. None of these transfers brought about the disorder, all beets remaining healthy. As this mallow plant had been proven to be infected in the past experiment there is no doubt that unfavorable conditions were responsible for the negative results obtained. There may perhaps be a latent period in the life cycle of the causative agent while in the plant, or the agent may have been unable to withstand the unfavorable temperature.

The actual production of the condition in a healthy mallow plant by a virulent insect, and its subsequent transfer from the mallow to a healthy beet by a non-virulent insect, is the crucial point in the experiment. Small seedling plants for this test were grown in insect-proof cages and used as soon as they were large enough to be easily handled. First, six insects known to be virulent were placed on each mallow plant and were allowed to remain for a considerable period, after which they were removed. Non-virulent insects were then placed on the same plant and allowed to remain at least one week, when they were removed and placed on healthy beets. This experiment was conducted in a room in the laboratory where conditions were more favorable for the development of the condition. The results obtained are given in Table II.

TABLE II.—EXPERIMENT IN THE INFECTION OF HEALTHY MALLOW PLANTS BY VIRULENT SPECIMENS OF EUTETTIX TENELLA AND THE TRANSFERENCE OF THE CURLY-TOP INFECTION TO HEALTHY BEETS THROUGH THE AGENCY OF NON-VIRULENT SPECIMENS OF THE INSECT

Exp. No.	Virulent Insects Placed on Mallow	Date Removed and Non-Virulent Insects Placed on Mallow	Date Placed on Healthy Beets	Date when first Symptoms of Curly-top Appeared	No. of Insects Used
1	Nov. 10, 1915	Nov. 30, 1915	Dec. 14, 1915	Jan. 20, 1916	6
2	Nov. 10, 1915	Nov. 30, 1915	Dec. 14, 1915	Feb. 15, 1916	6
3	Dec. 1, 1915	Dec. 15, 1915	Dec. 27, 1915	Mar. 10, 1916	6
4	Dec. 1, 1915	Dec. 15, 1915	Dec. 27, 1915	Mar. 29, 1916	6

CONCLUSION

The foregoing experiments show the possibility that common weeds may assist in the perpetuation of the infectious factor which causes the curly-top of sugar beets. That these findings are of the greatest significance can be easily understood. Indeed they introduce a definite field of investigation for the control of this most destructive condition. One fact stands out most prominently from all evidence gathered up to the present time, namely, that the insects must be infected in order to be able to cause the disturbance. From their nature these insects in themselves are unable to produce the disorder. Hence, affected plants are required for reinfection of the insects before a general outbreak can be started. There must be present either some beets affected with curly-top in the fields or weeds which harbor the virulent factor, even in a symbiotic way. Clean cultivation, already extremely desirable from the standpoint of diseases and insect pests, especially during the period that no beets are in the field, is thus necessarily indicated as a means of prevention. Even though all vestiges of affected beets from the previous year have disappeared, and all volunteer beets have been eliminated, there remains the possibility that certain weeds, such as mallow, may harbor the virulent factor during hibernation. After clean cultivation has been put into practice attention must be directed to the surrounding native vegetation. The discovery of the original host plant among this vegetation is the next problem to be considered, and investigations are in progress to determine this point.

SUMMARY

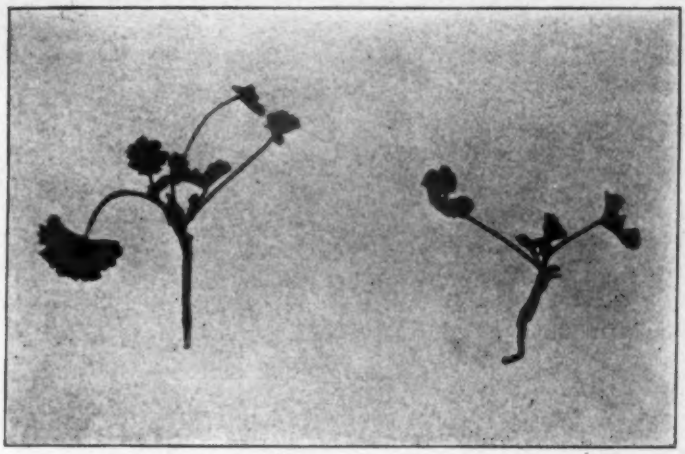
Malva rotundifolia, a common weed in the beet fields, has proved to be at least a symbiotic host of the virulent factor of curly-top of sugar beets.

Individual insects of the curly-top leafhopper (*Eutettix tenella* Baker) known to be non-virulent were placed on sickly-looking mallow

1

2

1, Healthy plant of mallow (*Malva rotundifolia*). (Original.) 2, Sugar beet showing typical curly-top infection. (Original.)



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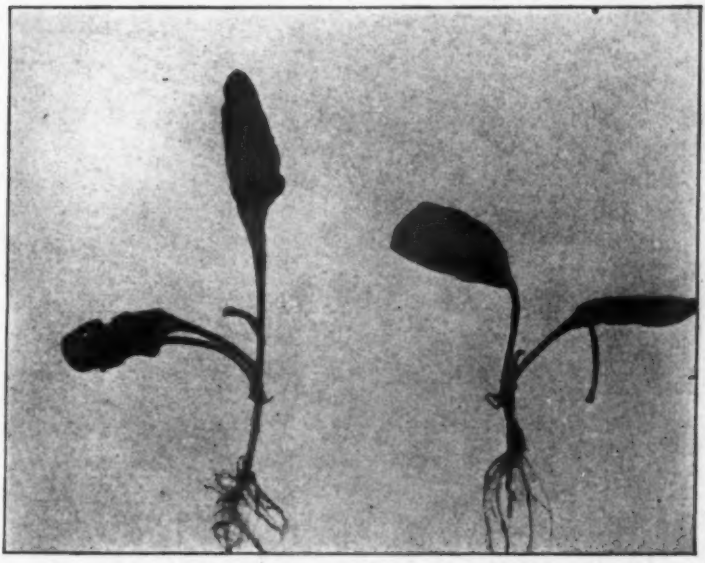


2

1, Mallow plant (*Malva rotundifolia*) harboring virulent factor causing curly-top of sugar beets. (Original.)

2, Beet plants showing effect of curly-top infection transferred from mallow plants. (Original.)

plants in the field. They were subsequently placed on healthy beets grown from seed in insect-proof cages. The condition was produced in four experiments.

Insects known to be virulent were placed on healthy seedlings of *Malva rotundifolia*. After a certain lapse of time they were removed and replaced with non-virulent insects which were later transferred to healthy beets. All transfers brought about the disorder.

These discoveries throw considerable light on the nature of the condition of sugar beets called curly-top, and establish beyond doubt the possibility of preventing or limiting injury by this condition through the control of the leafhoppers affecting the beets, and through the establishment of clean cultural methods, by means of which infected plants which act as hosts to the leafhoppers may be removed from the vicinity of beet fields.

RELATION OF THE COMMON ROOT MAGGOT (PEGOMYIA FUSCICEPS ZETT.) TO CERTAIN CROPS IN LOUISIANA

By E. S. Tucker, *State Agricultural Experiment Station, Baton Rouge, La.*

Attacks on Young Tomato Plants

A number of injured tomato plants ranging from five to six inches in length and a few specimens of a small maggot said to have been found burrowing in the stems of similar growth were brought to the writer for examination on March 3, 1914, by a merchant of Norwood, East Feliciana parish, La. He stated that a gardener of his home town had lost more than 1,000 plants like the samples, from stock grown under culture in a coldframe, all having failed in the short time of about two days. When the bed was covered on Saturday evening, February 28, the growth appeared to be perfectly healthy; but on opening the frames on Monday, March 2, the owner noticed many drooping plants, and by close examination, determined the cause of damage through discovery of some maggots in the stems. Other growers also complained that their beds were likewise being depleted.

The sudden loss of great numbers of plants in such manner naturally excited some alarm among the growers, who feared that the trouble might become more extended and thus restrict their production of a tomato crop for the approaching season. Since none of the gardeners had ever before known an enemy of this kind to do any harm to tomato plants, the question of its identity and life-history, and how to deal with it, presented an entirely new problem. For the benefit of the community, therefore, the merchant hastened on a visit to consult

an entomologist for the purpose of obtaining information about the pest and means of checking its ravages.

Careful examination of the injured plants submitted by him revealed two distinctive effects of attacks, denoting both external and mining tendencies of feeding by the enemy. As the stem was the only part showing violence, the plants had consequently received wounds in a very vital place. Even cuts of slight size appeared to have eventually produced nearly as fatal results as had been caused by extreme inflictions. Ample evidence of the primary and of course the more prevalent mode of attack was exhibited by the presence of scars. They also commonly demarcated the secondary damage that was disclosed by a tiny opening leading into the interior of the stem. These scars varied from a mere scraping to a rough cavity in the tissues, all being made conspicious by their black discoloration. They were located at different heights on the stem, ranging from near the roots to a distance of an inch or more above, but evidently depending on the depth of insertion in the soil.

In most instances, a plant had suffered but a single infliction. Burrowed stems, however, had usually become too weak to support the upper part of the plant, yet the fallen top remained attached at the infirm place by the shreds of withered tissues. The longest burrow found in any stem measured fully an inch. Every boring extended upward from a scar where a maggot had manifestly worked its way into the heart and there pursued its ravages. Although no additional maggots could be detected, the injuries were typical of operations by such creatures. The specimens at hand agreed very closely with a figure of the corn seed maggot. But positive identification of the species involved the necessity of securing adult examples or the actual fly.

While no occurrence of exactly the same nature had ever before come to the attention of the writer, yet reference to publications treating of maggots known to attack roots and stems of vegetables afforded a choice of several methods of protection against such foes, as recommended by authorities on the subject. Among the methods given, selection was made of two whose applications would seem to be most feasible under the circumstances, and a trial of each was accordingly proposed. One of the treatments required the use of oily sand, which should be prepared by mixing a cupful of kerosene in each pail of dry sand as would be needed, this to be placed close around the plants remaining in the beds. The other recourse depended on a liberal scattering of tobacco powder, which substance is claimed to serve as a fertilizer in addition to its repellent property against the maggots.

In order to render assistance based on practical experience in dealing

with this sort of enemy under Louisiana conditions, a visit for investigation was deemed expedient to acquire an understanding of the habits of the depredators with relation to the cultural practices of the truck growers, and to learn whether more than one kind of pest were involved or not, and also to determine the results of steps taken for preventing further harm by such foes. With this object in view, the writer proceeded to Norwood on March 6. For courtesies received, his thanks are especially extended to the merchant, who, in generous service to the growers, not only furnished accommodations, but gave his time, for facilitating observations.

Through a survey of the situation, not much difference was found to exist in cultural management, although some beds showed more careful preparation than others and had produced a superior growth of plants. As a general practice, the bedded soil had been heavily enriched with a commercial fertilizer said to have contained a quantity of cotton seed meal. Only one grower stated that he had used stable manure, yet his plants were beginning to fail. All the beds had been prepared solely for the forcing of tomato plants, being protected by the construction of a coldframe enclosing each one. While the entire stocks of these coldframes had been transplanted from seed beds, yet none of the growth left in the original places on account of its inferior size was said to be molested by maggots.

Since the owners of the depleted frames had made good progress in replanting them, leaving the surviving plants of the first lot as they already stood, but filling in with a fresh supply taken from seed beds, the great loss of stock so far sustained was therefore only partially shown. Enough evidence was seen and learned, nevertheless, to prove that the extent of damage together with imminent danger of further ravages had brought the growers to face a grave predicament. The replacements of plants necessarily consisted of smaller growth than was desired, and unless these settings could be saved, the reserve stocks in seed beds might be insufficient to depend on for growing as much of a crop as was planned, besides being apt to mature late. A shortage of the advanced growth would handicap the producer, at least by limiting the yield of fruit in time for market early in the season when high prices rule.

In all the instances where depredations had been committed, nothing else than maggots could be held accountable for the principal destructive work. Very seldom was any indication of cutworm damage or sign of disease apparent.

One gardener, whose stock was inspected, claimed that he had lost about 3,000 plants of a size like the living growth of the same lot left in his coldframe. These remaining plants averaged 8 inches in

height measuring from the base of the stem. The spaces made vacant by the losses had just been reset with slightly smaller stock. Yet scarcely any of the plants kept from the first setting were found to be in a sound state. Most of them looked healthy as they stood, showing no injury above ground, when in fact, nearly every stem proved to be blemished by one or more wounds, all of which had been originally inflicted only on the part buried in the soil.

Deterioration by withering and decay following upon the wounds had in many cases reduced the tissues to shrunken and blackened shreds which broke apart on the slight strain of a pull exerted by efforts to lift the plants. Such defects commonly marked the starting point of a boring that penetrated upward through the soft heart, and these bored stems occasionally contained a maggot. During the day before, the owner took a number of withered plants and showed them to the merchant, who on opening the cavities, exposed as many as seven maggots infesting a single stem.

The heart of some stems had been excavated up to the juncture of the lower branches, and in one instance, a burrow extended onward for a short distance into a thick branch itself. Among the plants examined here, one happened to attract particular notice on account of a bunch of new rootlets which had grown out from the base of the stem just above a breach, the lower portion with the original root system having become withered and practically dissevered. Although the vitality of this plant indicated that it might attain to a fair growth, provided no other harm should befall it, such an event, however, could only be considered as a bare possibility.

A visit to the coldframes of another grower afforded a view of the effects of ruin as were displayed by part of a bed not yet replanted. Judging by the havoc presented here, the owner's opinion that his loss of stock amounted to 75 per cent of the entire first planting seemed to be well founded. By taking his estimate of shortage and allowing it to include all additional failures bound to occur among the remainder of the plants, a very conservative comprehension could be derived in respect to the plight of growers at large.

Menace to Garden Peas and Seed Potatoes

Attention was also called to depredations committed on young garden pea vines in the same locality, but the plants appeared to be fully able to withstand the injuries although the stems were badly scarred at points beneath the soil. So far as was ascertained, the stems had only suffered abrasions not much more than skin deep. The firm structure of the heart had evidently proved to be impregnable against attacks, and had therefore saved the plants from fatal damage. Search

for the enemy revealed it only in the pupal stage occurring in the soil at short distances from the plants. The finding of the pest in this form established the fact that the destructive stage, or maggot, had ceased its ravages in this field.

The work of maggots in seed potatoes could only be briefly investigated, but it certainly foreboded disaster to the planting that was first inspected. Tubers that were dug up for examination consisted in part or almost wholly of a rotten mass infested with the maggots. Reduction of the parent stock in such manner meant that the sprouts must soon die for lack of nutriment. In a field of more recent planting where the tubers had just started to sprout, no defects came to view, although the stock was found to be endangered by numbers of maggots which reveled in the decomposing cotton seeds that had been put in the rows for fertilization of the crop growth.

Infestation of Cotton Seeds used for Fertilizer

The discovery of the maggots existing among the rotting cotton seeds buried under several inches of soil incited comment in regard to the manner in which the infestation could have been initiated. The introduction of these forms could not be explained in a way to satisfactorily attribute sufficient ability on the part of the pest at any stage to gain access into such a situation. The problem, however, admitted of a simple solution which happened to be revealed through remarks ventured by the grower. He pointed out the probability that the cotton seeds had become infested with maggots previous to the time when they were scattered in the field. According to his statement, he used these seeds for fertilizer because in the first place they constituted a quantity which by exposure to rain had been rendered unfit for planting or for sale. While being cast aside in such condition, the pile of spoiled seeds had likely attracted parent flies which had then deposited their eggs in the damp decomposing mass, thus resulting in the development of maggots under very favorable circumstances.

Comments

As adult flies cannot oviposit below the surface of the ground to any depth, no maggot on hatching from an egg placed on the soil would be able to penetrate far down unless guided by the stem of a plant. By such means as the latter, the maggots can without doubt reach the tubers of potato sprouts.

In proposing an experiment for the benefit of a grower, he was asked to place a few glass jars in an inverted position over some of his failing plants for the purpose of trapping a number of flies when they should emerge from the enclosed soil after completing their develop-

ment from the maggot stage. Specimens captured in this way were desired by the writer for study, but the arrangements failed to be carried out.

However, adult flies collected in and near the coldframes on March 6, and reared ones maturing on March 26–31, from infested material consisting of earth and pea sprouts, potato tubers and cotton seeds, filled expectation of the species being *Pegomyia fusciceps* Zett.

Destruction of Other Potato Plantings

As a matter of previous record concerning the same insect, a complaint of damage to seed potatoes, accompanied by a sample of the tubers showing infested condition, was received from Valverda, Pointe Coupee parish, La., bearing the date of March 19, 1913. The sender stated that the tubers had been planted during the month before, the planting having been begun on the 18th. The fields thus planted comprised about 20 acres in the Triumph variety and 5 acres in the Irish Cobbler. All of the seed stock had been obtained from Maine and it had arrived in excellent shape. However, it was treated with formalin; and as far as could be seen, germinated nicely. A good many little sprouts duly appeared above ground but were nipped by a frost on March 16.

Upon examining the propagating tubers on the day as noted by letter, every piece of potato without exception that the planter then dug up was found by him to be infested and practically spoiled by small maggots. He further asserted that the same enemy had occurred during past years in considerable numbers on seed potatoes, but not to the extent of spoiling them. As a large part of his present plantings had been made on land that had never produced potatoes, he was at a loss to account for the general prevalence of the foe. It operated just as numerously on the plantings in such land as on others in ground where a potato crop had been grown before. The fields were said to have been well drained, the soil having remained loose and in good tilth even after the heavy rains of the preceding week.

While acknowledging that the damage done at the time left little hope for a crop worth cultivating, yet the grower asked for information about remedies and also desired to know if any similar case where the prospective growth had been ruined had ever come to the attention of the writer or his agricultural associates. No satisfactory advice could then be given in reply since the injuries under such circumstances presented a subject concerning which no dealings had been experienced in Louisiana and but scant enlightenment was available. As was shown by the sample, decay had followed the attacks by the maggots until the combined ravages by both agents had greatly reduced the supply of nutriment in the parent stock.

Not knowing, however, but that the sprouts might yet succeed in establishing themselves, the presence of the maggots was consequently on first notice not regarded by the writer as a serious menace. But a subsequent report made by the planter, under date of April 17, conclusively affirmed the opposite of this impression. He then wrote that the results were just about what he had expected: no stand was secured at all from the impaired seed stock, though a later planting attained to perfect growth.

Adult flies, which proved to be the species, *Pegomyia fusciceps* Zett., matured on April 1–3, from the maggots received in the rotting tubers for examination.

Another loss of a planting of seed potatoes on account of attacks by maggots occurring again in Pointe Coupee parish, which complaint was made by a grower at Ventress, under date of April 1, 1915, seemed to indicate that some especially favorable condition for the pest existed in the country there. The stock was said to have been obtained from Maine, then having been planted on March 6. At the date of writing, all of it had become rotten, which state was attributed to the work of "worms." The samples submitted for examination consisted of rotten pieces of the potatoes infested by numbers of maggots. To all appearances, these larvæ represented the species *Pegomyia fusciceps* Zett., though they failed to produce adults.

The possibility that the maggots might not have been entirely to blame for the rotting of the tubers was pointed out in reply to the grower's request for information. Their occurrence may have followed decomposition induced by cold wet soil. In case the growth of sprouts had been delayed by the latter conditions, the seed had very likely started to rot before the parent flies deposited their eggs, with the result that the issuing maggots were immediately attracted to the rotting tissues. Owing to their scavenger habits, the maggots naturally reveled in the decomposed matter and therefore hastened the spoiling of the seed.

If means in accordance with a better knowledge of the pest at this time had been employed early enough to prevent the maggots from reaching the seed, the prospect of obtaining a stand of sprouts might have been insured. The most practical measures in such respects would have depended on spraying the sprouts as soon as they had appeared above ground, with a solution of lead arsenate, preferably in combination with Bordeaux mixture. But the best that could be done in case the stand of plants proved to be inadequate for a crop would be to replant the field.

Killing Young Corn

A correspondent writing from Tallulah, Madison parish, La., on April

30, 1913, sent a few young corn plants which he stated had been gathered from a field where the crop growth was being destroyed by "worms" attacking the base of the stalks. He asserted that this corn had come up to a perfect stand, but at the time of writing, a great many of the sprouts had died, while others looked unhealthy as if affected by disease. Still some appeared outwardly to be sound and vigorous although being generally found infested by the worm-like enemy. A large part of the field had already been plowed up and planted to cotton, but he had left a portion for an experiment to determine whether the plants would be able to recover and produce a crop or fail to be worth further attention.

In response to his request for an opinion regarding the outcome of the latter course, and for suggestion as to any method by which the foe might be exterminated, very little advice could be given, because preventive measures are about all that can be employed against enemies of such nature. Then the application of precautionary treatments for field crops such as corn would likely be of questionable value considering the cost of labor and material required.

His belief that the pest was a larval form of some species of beetle failed to be sustained by examination of the material furnished. Injuries to the stalks were observed to have resulted from small shallow cavities evidently caused by a scraping away of tissues on the base close to the roots. Only a few dipterous larvæ could be detected, and all occurred in the cavities of one plant. The insect was regarded as the common root maggot (*Pegomyia fusciceps* Zett.), also called the seed-corn maggot. It therefore appeared to be the real culprit responsible for the attacks.

The absence of larvæ in the other stalks given examination may have been due to the emergence of the forms from the cavities and consequent loss in transit, or else the maggots had gone into the soil for pupation before the plants were collected. The damage inflicted was entirely different from that of deeper bored injuries as are committed by the southern corn rootworm (*Diabrotica duodecempunctata* Oliv.), which insect commonly ruined early stands of corn in the central and lower sections of the state. Neither were the roots attacked nor stems bored in this case. The plants measured from 12 to 15 inches in height and had pushed out short prop roots. As not enough maggots could be secured for rearing of the species, the name as cited should be substantiated by positive determination of the insect involved.

Pest of Hotbed with Tomato and Cauliflower Seedlings

On receipt of specimens of insects taken from a hotbed, which material accompanied an inquiry forwarded from Edgard, St. John the

Baptist parish, La., January 21, 1916, an examination of them revealed a single adult fly of the species *Pegomyia fusciceps* Zett., a plump red mite which may have been an enemy of the fly, and a number of springtails, possibly *Smynthurus sp.* The transmitter thought that such insects had cut the roots of the young plants and also eaten some of the tomato and cauliflower seeds. Advice was requested as to what treatment should be given. Answer to this question is covered in extract presented under the heading of "Reference." Considering that the occurrence of the fly indicated an infestation of the bed by maggots of its kind, the cutting of the roots of the plants could well be attributed to attacks by the latter form of pest. These injuries might have been made worse by work of the springtails, which very likely did other harm, including the destruction of the seeds.

Ravages in Onions

Ravages committed by the same insect in onions were brought to attention through a report which came to hand from Paulina, St. James parish, La., dated January 22, 1916, stating that a pest in the form of a "worm" had cut into the plants at the surface of the ground. The trouble occurred in a patch of transplanted Creole onions which had been put out three weeks before on land that had produced sorghum during the preceding summer and Irish potatoes for a fall crop. Other patches of onions planted where sweet potatoes had been grown were declared to have no enemy of the kind at all. In the first plat, the foe was found by opening the little onions. It was described as a white worm of small size, measuring about one eighth of an inch in length and being no thicker than a needle.

As desired, samples of the infested onions were transmitted six days later. From specimens of the insect thus obtained, the species was identified by Mr. W. R. Walton, Federal Bureau of Entomology, through the kindness of Dr. F. H. Chittenden. The instructions furnished in regard to treatments for checking further advances of the pest emphasized the importance of pulling up and destroying all the infested onions in order to kill the maggots before they could develop into flies. Warning was given that the insect if allowed to mature would be able to reach other patches, and these adults by depositing their eggs all through the fields would be very apt to bring on a widespread infestation with the issue of a new brood of maggots.

Reference

Tucker, E. S. Stem Maggots Attacking Young Tomato Plants. 1914. Southern Farmer (Baton Rouge, La.), vol. 1, No. 9, May, p. 9.

A notice of the losses experienced by the growers at Norwood, La., contains the following remarks on control of the insect: "Practical methods of checking or preventing attacks on the tomato plants were promptly employed, and two kinds of

treatment gave promise of good results. One depended on a liberal scattering of tobacco powder on the beds. This material is claimed to serve as a fertiliser in addition to its repellent action on the maggots. The use of a trade preparation called 'Pyrox,' which was sprayed on several beds of plants, seemed to afford almost complete protection to the growth. Where such applications had been made upon plants at time of setting and later, the stock was not molested by maggots nor even cutworms, and showed no sign of disease. Growers who adopted this course secured stands of advanced stock. That the enemy was overcome by the above means is evidenced by the absence of any further complaint, and a full tomato crop is therefore believed to be assured."

A BUPRESTID HOUSEHOLD INSECT (CHRYSOPHANA PLACIDA LEC.)

By H. E. Burke, *Specialist in Forest Entomology, Branch of Forest Insects, Bureau of Entomology, U. S. Department of Agriculture*

During the past year, this species, through a slight change in habit, has become, locally at least, an injurious household insect. Normally it lives in the wood of dead limbs, tops and scars on the trunks of living trees. Fire scars and blazes are very often found to be infested in the higher mountain regions of the Rocky Mountain and Pacific states. The larvæ mine the wood riddling it with the small worm holes which are filled with the fine dustlike borings. In the average forest a good deal of damage is done to the timber of the trunks of injured standing trees.

It is not such a long step from the wood of the standing tree to the wood of window casings and door frames. This seems to be the first case reported, however, where a Buprestid normally living under the same conditions as *Chrysophana* has made the step.

In the case under observation the frames of several windows in various office buildings in Placerville, Calif., were found to be riddled by the mines of this species and adults were taken in the act of emerging from the wood. One building was erected over thirty years ago and another over twenty so the casings evidently were infested long after the buildings were erected. The work indicated that the wood had been infested and reinfested several times and probably in a number of cases the adults never left the room into which they had emerged but mated and the females oviposited in the same casings or adjoining ones. The casings appeared to be of sugar pine (*Pinus lambertiana* Dougl.).

That this species is quite adaptable in regard to host is also indicated by the fact that it is a burrower in cones. During the past few years it has been found several times in the cones of the knobcone pine (*Pinus attenuata* Lemmon). These cones remain on the tree a number of years and are hard and dry, more like a branch than the average cone.

The life-history of *Chrysophana* is very much like the life-history of

the average wood-boring Buprestid. It lives in the wood as a larva for two or three years and pupates and transforms to the adult in a pupal cell in the wood. Pupation takes place from July to October and the transformation to the adult in a few weeks afterward. The adult then rests over the winter in the pupal cell and emerges from the wood the next spring or summer, from March to September. Adults have been collected flying or crawling in the forests from March 20 to August 24.

During the past fifteen years *Chrysophana placida* has been taken by members of the Branch of Forest Insects, Bureau of Entomology, United States Department of Agriculture, in the localities and host trees listed herewith.

Distribution

California: Fallen Leaf, Pyramid Ranger Station, Placerville, Markleeville, Shingle Springs, Sterling, Yreka, Tallac, Lake Valley Ranger Station, Echo Lake, Meyers, Wrights Lake, Monumental, Vade. *Colorado:* Florissant. *Oregon:* Sumpter, Waldo, Ashland. *Utah:* Panguitch Lake, Kamas. *Washington:* Des Moines.

Host Trees

Mountain, white or silver pine (*Pinus monticola* Dougl.), sugar pine (*Pinus lambertiana* Dougl.), single leaf pinon (*Pinus monophylla* T. & T.), yellow pine (*Pinus ponderosa* Laws), rock pine (*Pinus scopulorum* Engelm.), jeffrey pine (*Pinus jeffreyi* Oreg. Com.), lodgepole pine (*Pinus murrayana* Oreg. Com.), digger or gray pine (*Pinus sabiniana* Dougl.), knobcone pine (*Pinus attenuata* Lemmon), black hemlock (*Tsuga mertensiana* Carr.), Douglas spruce (*Pseudotsuga taxifolia* Britton), Alpine fir (*Abies lasiocarpa* Nutt.), white fir (*Abies concolor* Parry), red fir (*Abies magnifica* Murr.), giant arborvitae or western red cedar (*Thuja plicata* Don.).

CONTRIBUTION TO THE LIFE-HISTORY AND HABITS OF THE SPINOSE EAR TICK, ORNITHODOROS MEGNINI

By William B. Herms, *University of California*

The spinose ear tick presents a problem of considerable importance to the animal husbandryman in nearly all of the southern half of California, particularly in the Imperial Valley where calves become seriously infested and die from what the ranchers call tick fever. Experiments and field observations on this species have been carried on more or less continuously by the University of California Laboratory of Parasitology during the past three or four years. From our records it would seem that few if any warm-blooded animals coming within the reach of this tick are exempt from attack. Calves evidently are most liable and suffer most severely, many dying from the effects.

Infested calves shake the head vigorously, become emaciated, often race about madly until completely exhausted. The ears become inflamed and the secretion of wax is greatly stimulated. Deafness is said often to result in infested horses and mules.

The following account is by a man whose ear was inhabited by a tick of this species. This account is worthy of note because the course of events is here rather accurately given, together with the sensations aroused and other matters of interest. Mr. L., writing from Lancaster (California), states: "I left Berkeley with a horse and wagon on the 3d of September (1915) and drove about four hundred miles to Lancaster, Los Angeles County. I slept on the ground every night except one, arriving here on September 15. Some of my camping places were in, others along-side of, cattle ranges or pastures. One of the places I discovered before morning to be a regular camp for twenty or thirty cattle of all sizes. This is where I did not sleep on the ground. The cattle came in after I had made camp about dark and it was too late for me to find another place, so I moved my bed into a small shack, near the barn with old straw on the floor, which was about a foot above the ground. Still I was right among the cattle. This was the night of September 5, at Corrall Hollow, east of Livermore. The last night out, September 15, I slept on land that is used only for grazing and have been working on similar ground ever since; however, there are only a few cattle on the range. My other sleeping places were mostly along the roadside, and sometimes cattle were around. At other places there were none and I think there have been no cattle near the house I live in for several years, or perhaps a few passing near it once in a while." Our records show that Mr. L. went through territory where the spinose ear tick occurs. In his first letter, dated December 10, 1915, he says "I am sending you . . . a bug . . . which came out of my ear, and which was living there probably six or seven weeks. . . . About six or eight weeks ago I began hearing unusual noises in my left ear. Sometimes hours would pass without hearing them; sometimes every few minutes, either day or night. The noise would saw awhile without any regularity as to time or duration. I could feel no movement in my ear like anything alive. Finally I thought I had better have it examined, so went to a local physician and told him I thought something was in my ear. He examined it and said 'Yes, there is something in there. I'll see what it is and what I can do for it.' After prodding around awhile he asked, 'What do you suppose that thing is in there?' I replied that I did not know. 'Well, it is a live bug, but I killed it.' He pulled out what looked like a clot of good red blood, about the size of a small pea, mixed with small bits of soft membrane. Then he

washed the ear with peroxide and gave me the syringe and a bottle of peroxide and told me to wash it a couple of times a day for two or three days. . . . I used the peroxide as directed, but the noises did not seem to stop and soon I concluded that they were about as before. . . . Finally I made up a dose of peroxide as hot as my ear would stand and about the third or fourth shot with the syringe this ugly thing came tumbling onto the ground, and the ear has been apparently alright ever since. This was last Tuesday, December 9, nine or ten days after the doctor did his job."

The above letter furnishes evidence to the effect that the tick entered the ear of the man while sleeping on the ground sometime between the third and fifteenth of September. From what is already known of the habits of the species, the tick almost certainly entered his ear as a larva. The specimen which left the ear of the patient December 9 was a full grown female. The time was, therefore, about nine weeks. This specimen remained alive without food in a small shell vial on the writer's desk until about December 1, 1916, nearly a year, during which time there were no further molts.

Oviposition

In order to ascertain the exact time expiring between the last molt and the deposition of eggs, a number of females previous to the final molt, were placed in Petri dishes with one or more males and kept in an insectary at 26°±3° C. except female No. 3 (see table) which, after about 60 days, was subjected to temperature as low as 0° C. The following table shows the result of this experiment.

Table I.—Showing Time Required between Final Molt and Oviposition, also Date of Copulation, Number of Ova

No.	Date Molted	Date Placed with Male	Date of Copulation	Date of Oviposition	No. of Ova Deposited	Days between Copulation and Oviposition
1	10/22/15	10/23/15	10/23/15	11/ 6/15 11/ 8	10 44 } 54	14
2	10/24/15	10/27/15	Not observed	11/24/15	186	28(?)
3	10/24/15	10/27/15	10/27/15	11/27/15 12/3 12/ 3 12/ 4 12/ 6 12/ 8 12/20 3/24/16 4/13 4/30	7 13 19 5 88 94 43 166 103 25 } 562	31
4	10/19/15	10/21/15	Not observed	12/ 5/15	7	37(?)
5	10/23/15	10/23/15	10/25/15	12/ 6/15 4/16/16 4/27	117 Not counted Not counted	42
6	10/24/15	10/30/15	11/ 5/15	2/15/16 4/1	25 Not counted	100
7	10/20/15	10/30/15	Not observed		No ova	—

An examination of Table I shows that copulation took place readily within a day or two after the last molt; and that in six cases egg deposition began in from 14 to 42 days after copulation or from 15 to 44 days after the last molt, with the number of ova ranging from 7 to 562. The longest period of oviposition noted was 155 days or 189 days after molting.

Incubation Period

Unfortunately a careful record of all egg layings was not kept, but the records made in this connection are of interest nevertheless (see Table II).

Table II.—Showing Incubation Period for Ova of Ornithodoros megnini

Date of Oviposition	Date Hatched	Incubation Period	Temperature
11/ 8/15	12/1/15	23 days	Room temperature 21° C. (steam heat regulated by thermostat)
11/24/15	12/11/15 to 12/14/15	18 to 21 days	Ditto
12/ 2/15	12/22/15 to 12/24/15	20 to 22 days	Ditto

The above table though based on few observations shows that it is possible to secure oviposition during the winter months (November and December) and that the eggs hatch in a room temperature of about 21° C., requiring from 18 to 23 days incubation.

Longevity of Larvæ

In a series of experiments in which the larvæ were kept in darkened receptacles at room temperature, during the months of November, December and January it was found that the range of longevity was from 19 days, the shortest, to 63 days, the longest, with an average of 44 days. This series included seven sets of larvæ hatching during a period of 32 days.[1]

Conclusions

The spinose ear tick, *Ornithodoros megnini*, enters the ears of both man and beast causing losses particularly in calves.

Oviposition and emergence of larvæ may take place during the winter months, November, December and January, under laboratory conditions. It should be borne in mind that under field conditions this takes place during the summer and autumn months.

The adult female may live 355 days without food in a glass vial at room temperature.

[1] The writer wishes to acknowledge the assistance of Mr. M. H. Ray, a student in parasitology, who deserves much credit for his patience and care.

Copulation takes place within a day or two after the final molt.

Oviposition occurs in from 14 to 42 days after copulation with a maximum period of oviposition of 155 days.

The number of ova per female ranged from 7 to 562.

The incubation period at room temperature ranged from 18 to 23 days.

The longevity of larvæ ranged from 19 to 63 days with an average of 44 days.

A FLY CONTROL EXHIBIT

By C. W. Howard

In the autumn of 1915 it fell by lot to the writer to prepare for the State Fair, the major portion of the exhibit of the Division of Economic Zoölogy, of the Agricultural Experiment Station. The task seemed difficult, for in years past we had nearly exhausted the possibilities of preparing a new and interesting display of destructive insects. But as we have been trying for some time to impress upon our rural and farming population, certain facts about house-fly control, this seemed to be the opportunity to press home some of these facts in a telling way.

In preparing the exhibit, we had in mind the fact that fly elimination on the farm is extremely difficult, and that especial attention must also be given to sanitary arrangements, as well as to actual fly control in order to prevent disease transmission. Sanitation has been sadly neglected on most Minnesota farms, but the more progressive farmers are awakening to its necessity and are ready for suggestions.

The exhibit was called, "The Flyless Farm." A farmstead about 10 x 15 feet was laid out. The Division of Farm Management was called upon to advise as to the proper relation of the buildings, and the Division of Engineering for plans for the buildings. The entire exhibit was, therefore, correct in every detail and in accordance with the recommendations which the Experiment Station is sending out to farmers.

For the actual construction of the buildings, etc., we were fortunate in securing the services of one of our students, who is unusually apt at mechanical work. "Compo-board" served admirably as constructive material. The buildings were so made as to be collapsible and easily packed for transportation. They were of large size, built to a scale of one-half inch, the house for example being 14 x 15 inches, and the horse barn 18 x 25 inches, so that every detail could be practically perfect. This accuracy of details fixed the attention of many observers. A large green painted canvas covered the table on which the exhibit was placed, with the roadways marked out in gray.

The following buildings were shown: dwelling, dairy barn, horse barn, hog house, milk house, and outdoor toilet. The only necessary farm building lacking was the poultry house. Every building was fitted with screens over windows and doors, and the hog house had swinging doors into the run-ways, with miniature pigs passing through. At the door of the dairy barn was shown a miniature manure spreader receiving a load of manure from the manure carrier and ready for the daily removal to the field. On the other side was a model of a maggot-trap. At the horse barn were shown manure bin and manure closet for we knew that many of our visitors would be from villages and towns where such outfits could be used.

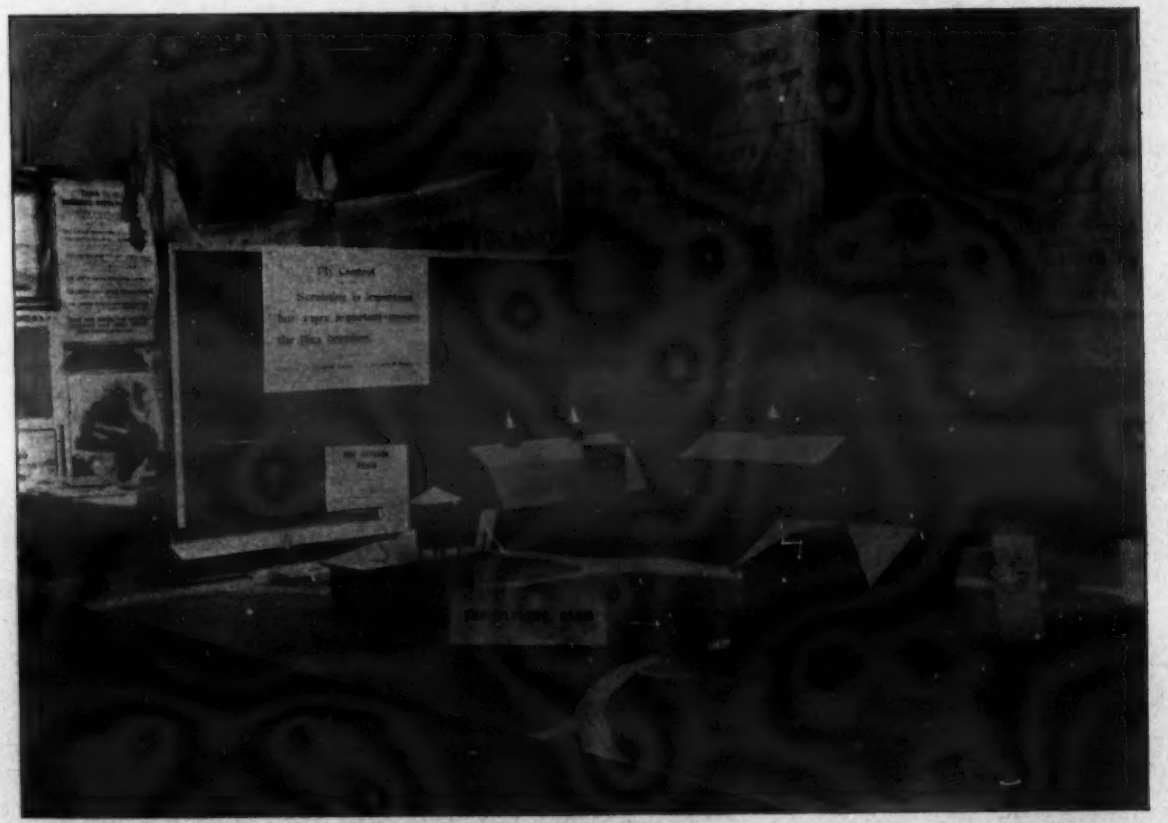
The milk house was removed from the stables, and beside the water tank. Windows and doors were fitted with screens, and a screened enclosure contained shelves on which pails and tins were airing. The dwelling, besides screens on windows and doors, was provided with screened porches, both front and rear. At the back door was a garbage tin. A portion of one side of the house was removed to show connection of kitchen sink and washbowl, bathtub and closet in the bath room, with a sewage system. At a convenient distance from the house, a model Imhoff septic tank was let into an excavation, connections to the house and outlet being indicated. The outdoor toilet was a perfect model of a flyproof, sanitary privy, of the bucket type.

An abundance of labels explaning every detail and a leaflet, which had been prepared on fly control to accompany this exhibit, gave full information to those who did not wish to ask questions of the attendants.

The success of this exhibit was much greater than had been anticipated and many people went away with a definite idea about farm sanitation, especially about the construction and use of septic tanks.

The cost of the models was not very great, approximately six weeks were required for construction. Labor and material have totaled about $200, the cost of publishing the fly leaflet being in excess of this. This year the flyless farm has been again exhibited at the State Fair, at the request of the Women's Federated Clubs, and will also visit several county fairs.

We are making additions to it as they suggest themselves. For example, this year we have added a model of a mosquito-proof water tank at the corner of the house. The models are very durable and we hope will last long enough to visit every county fair in the state on their mission of better farm sanitation. To the average individual in Minnesota, whether rural or city dweller, it conveys more practical information on the house-fly question, than all the leaflets we have ever printed.



Minnesota Fly Control Exhibit

A FEW NOTES FROM KENTUCKY

By H. GARMAN, *Lexington, Ky.*

With a very cold, cloudy, backward spring, insect problems have not come to the front in Kentucky as early as usual, but several insect pests have already claimed some attention.

The Hessian fly is being closely studied in the western end of Kentucky with a view to learning more of variations in its life-history from season to season. The adults have been abroad since March 25 on wheat sown September 28 and are numerous in that end of the state, though the wheat itself was in many places destroyed by frost and the promise for a crop is very unsatisfactory. The evidence secured by us last fall and this spring shows that owing to the influence of excessive drought in delaying volunteer wheat and also in keeping farmers from planting early, few or no adults emerged in the fall of 1916. But when flaxseeds were brought indoors at that time the adults came out in a few days, showing that they were ready and would probably have emerged in 1916 as they appeared to have done in 1915, if we had had a week more of warm weather. As it chanced, cold weather put a stop to their activities in October. With the first warm days they came out this spring. I am still of the opinion that a brood of adults matures in the fall in this region during some of our long open falls. We hope to solve this question next fall.

The buffalo gnat (*Simulium pecuarum*) was abundant for a day or two in one county in Western Kentucky this spring. Some mules were actually killed by it. It disappeared as suddenly as it came, leaving farmers wondering as to where it came from, some of them holding that it came from some distance on a cold west wind. Examination of the locality showed it entirely unsuited to the breeding of the insect. The streams are small, and dry up completely, it is said, in summer. Some pupæ of a Simulium were collected at the time in partly submerged willow in the edge of a creek. These appear to be of the type of *S. venustum*, though a determination based upon the pupal characters seems not to be safe in view of present knowledge of the life-history of our species. As a matter of fact, in the two cases of outbreaks of buffalo gnats which I have investigated in Kentucky, neither larvæ nor pupæ that can be considered as belonging to the species were discovered, and the local conditions were not such as have been described as suitable for the breeding of the pest. It is evident that there is much yet to learn about the life-history and habits of the buffalo gnat.

The Red-legged Flea-beetle (*Crepidodera rufipes*) of Peach Trees.—The first instance of injury from this introduced pest in Kentucky came to my attention in the shape of specimens sent me from Lewis County, May 4, 1917, where they were reported as gnawing the leaves badly, and as being very difficult to destroy with the customary doses of arsenate of lead.

We were made to realize keenly the defects in our nursery inspection law recently by a sudden demand for a quarantine against the white pine blister rust. The Kentucky law makes no provision for quarantines, and in fact does not provide for any rules or regulations by any state official under which a quarantine may be established. With a federal quarantine of territory of which Kentucky is a part, state legislation is not now so badly needed, but we should have been able to act at once. The law needs amending to provide for such emergencies.

American foulbrood is giving us much trouble, especially about the edges of cities where a good many people keep bees, but handle them badly. The spread of the disease among such beekeepers is rapid and in many cases results in a complete extermination of the colonies. The inspection of apiaries will some day be demanded by our people. The rapid growth of interest in beekeeping in the state, and the pronounced success of some of our commercial apiarists and queen rearers, is calling attention to this need, and we expect it to result soon in a good law with ample provision for enforcing it.

It may be of interest to collectors of Coleoptera to know that the introduced Tenebrionid (*Blaps mucronata*) has recently appeared in some numbers in grain warehouses at Lexington. Dozens were secured January 20, 1916, in the basement of a seed warehouse under sacks and among grain refuse about the floors. It was subsequently found about a dump at the edge of Lexington where it had probably been thrown with refuse from buildings. The first specimens observed here were collected in 1914. We cannot see that it is doing serious mischief, though it feeds on grain. The eggs and larvæ have been secured, but have not yet been followed to maturity.

The wheat fly (*Oscinis variabilis*)[1] emerged in one of our cages this spring, May 2, developing from wheat planted October 2, 1916, taken up last fall and kept out of doors at Lexington until the insects ap-

[1] When it was first discovered on wheat in Kentucky the writer did not feel satisfied that it was Loew's *O. variabilis* for the reason that it did not agree well with his description. Professor Aldrich, in his List, placed it under *O. carbonaria* Loew, though apparently with some doubt. He has recently examined some of my material and now pronounces it *O. pusilla* Meigen.

peared. It would seem, therefore, that its eggs may be laid very late in the fall.

We are still working on the locust borer (*Cyllene robiniæ*) and have some problems connected with its injuries and ecology to work out during the season now opening.

AN APHIS PARASITE FEEDING AT PUNCTURE HOLES MADE BY THE OVIPOSITOR

By L. P. ROCKWOOD, *U. S. Bureau of Entomology, Forest Grove, Oregon*

Having had my attention called by Dr. L. O. Howard to the fact that probably no observation has yet been published on any parasite of an aphis feeding on the juices of the host at puncture holes made by the ovipositor, I present the following observation as of interest for this reason.

On September 8, 1916, while examining red clover stems infested with *Aphis bakeri* Cowen, an *Aphelinus*, previously reared from this aphis and recently described by Dr. L. O. Howard in the Proceedings of the Biological Society of Washington, vol. 30, p. 77, as *Aphelinus lapisligni* n. sp., was found in the midst of a colony of *A. bakeri* beneath a bract on a clover stem. The *Aphelinus* was observed to approach a medium-sized aphis which was feeding. The parasite examined the aphis with its antennæ, then walked away about its own length, turned its back to the aphis and exserted its long semi-transparent ovipositor which it plunged into the aphis, a little to one side of the anus. The *Aphelinus* kept its ovipositor inserted during a space of several seconds, and during that time backed up toward the aphis, apparently plunging the ovipositor deeper into the wound. The aphis showed some discomfort and excreted a drop of honey dew from the anus. The parasite concluded its operation, walked off a few of its own lengths and returned to repeat the performance during a much shorter period. The operation was repeated three times while under observation, the ovipositor being inserted each time in approximately the same place. Then the *Aphelinus* returned and placed its mouth to the wound, and apparently fed on the juices of the aphis for more than a minute. The aphis was not dissected so it is not known whether one or more eggs were laid in the aphis.

For instances of this feeding habit with other parasitic Hymenoptera and other hosts, consult the paper entitled "On the Habit with Certain Chalcidoidea of Feeding at Puncture Holes made by the Ovipositor," by L. O. Howard, JOURNAL OF ECONOMIC ENTOMOLOGY, vol. III, No. 3, June, 1910, pages 357–360.

EASTERN APHIDS, NEW OR LITTLE KNOWN, PART I[1]

By Edith M. Patch

The present paper resulted from the examination of the collection of Connecticut aphids lent by Dr. W. E. Britton. Several undescribed species were found, some of which were well known in certain collections without having made their way into literature. A few of these are briefly described by the writer of Part I, and the others are presented by Mr. Baker in Part II as he was already at work on the groups those species represent, and kindly undertook their examination.

Most of the species are described with reference to material from Connecticut, though a few not yet reported from that state are included.

Aphis viburniphila n. sp.

(Fig. 20, c, d, e)

Alate Vivipara: Head, eyes, and antenna black, antennal joint III and VI approximately same length and sub-equal to IV + V, III with about 20 sensoria extending whole length, IV with from none to several sensoria, beak extends to second coxæ; thorax black, prothoracic tubercles prominent, wings with rather heavy dark veins; abdomen glabrous, dark red to reddish brown both above and beneath, caudal portion black, four lateral dusky spots cephalad of the cornicles, cornicles cylindrical, black, about twice the length of tarsi, imbrications serrate; cauda and cornicle, black, paler at base; lateral tubercles present, that between cornicle and cauda being prominent.

Apterous Vivipara: Head black, antenna dark except proximal III which is pale, III with about 15 sensoria which are more numerous on distal half, IV with or without sensoria; thorax reddish brown with prothoracic tubercles: abdomen bright reddish brown with two transverse black stripes cephalad the cauda, cornicles and cauda black.

Apterous Ovipara: Tan-colored form with black cornicles which are slightly more than half as long as in the apterous vivipara; antenna without secondary sensoria; hind tibia but slightly enlarged with a very few sensoria on distal half.

The cotype localities are Orono, Maine, where the writer has collected this interesting aphid for ten years; New Haven, Connecticut, where it has been taken by Dr. W. E. Britton and Mr. H. D. Clark; and Plummer's Island, Maryland, and Great Falls, Virginia, where Mr. W. L. McAtee has collected it, specimens from all these places being examined at time of preparing the description. Mr. J. J. Davis writes (March 22, 1916) that he has this species from St. Louis, and from Chicago where it is sometimes a serious pest of the *Viburnum* in parks.

In Maine this species is present on *Viburnums* during the entire year, being conspicuously abundant during June, July and August. It

[1] Papers from the Maine Agricultural Experiment Station: Entomology No. 88.

attacks cyme, both during flower time and early fruiting, ventral leaves and the tender twigs. The insects are gregarious and their colonies are frequently wellnigh exterminated by hymenopterous parasites. It is sometimes present on the same *Viburnums* with *Aphis viburnicola* Gillette, *A. rumicis* Linn, and *Macrosiphum viticola* Thomas, but there is no need of confusing it with any of these species.

On August 24, 1912, and August 26, 1915, at Orono oviparous females were found to be numerous feeding at berry clusters and depositing eggs thickly in axil of leaf and between terminal stems. Males have not yet been recorded. The time of the hatching of the stem female has not been observed.

The writer has seen specimens from *Viburnum acerifolium* L., Maine and Maryland; *V. cassinoides* L., Maine; *V. dentatum* L., Maine and Virginia; *V. opulus* L., Maine and Connecticut; *V. plicatum*, Connecticut; *V. pubescens* Pursh, Maryland.

Aphis rumexicolens n. sp.

(Fig. 20, f, g)

Alate Vivipara: Antenna 6-jointed, on no frontal tubercle, III with about 14 sensoria irregularly placed along whole length, V shorter than IV, VI longer than III; beak short, not or scarcely reaching second coxa; venation rather heavy but not shadowed; abdomen with black dorsum and large black lateral spots, cornicle shorter than tarsus or cauda, slightly bulging; cauda broad and blunt, about the length of tarsus but up-turned and appearing shorter, with a pair of dorsal tubercles near base.

Apterous Vivipara: Antenna 6-jointed, III without sensoria, base of VI subequal to V; beak short not reaching second coxa: abdomen not showing in alcoholic mount the black maculations of the alate form, cornicle shorter than tarsus, not longer than base of VI, thick at base and abruptly narrowing, tip with flare.

The cotype locality is Wallingford, Connecticut, where a collection of apterous and alate vivipara and pupal nymphs was made June 9, 1913, from *Rumex acetosella* L., by Dr. W. E. Britton.

It is needless to say that this is no typical *Aphis*, but it does not seem to slip into any of the several genera newly erected from *Aphis* and the writer hesitates to contribute to the modern tendency of establishing new genera on specific characters,—a conservatism which has disadvantages of its own, it must be confessed.

Aphis saliceti Kaltenbach

(Fig. 20, a, b)

This insect has not previously been recorded for America. It was collected at Orono during late June and July, being abundant upon fennel (*Foeniculum vulgare*), July 25 upon *Heracleum lanatum*, and August 12 upon cultivated parsnip in 1913. The same year it was taken on cultivated parsnip July 25 at Machias, Maine, and on willow

(*Salix sp.*) July 30 at Cherryfield, Maine. Specimens have recently been submitted to the writer for determination which were collected from parsnip at New Haven, Connecticut, July 13, 1909, by Mr. A. I. Bourne.

The willow seems to have been the only host previously known for this species. That it accepts members of the *Umbelliferae* also is evident from these collections but the details of its life-cycle have not been worked out. This is "*A. saliceti* Kalt." of Buckton and of Theobald 1912, but evidently not of all writers.

Aphis davisi, new name

It seems necessary at this time to rename the aphid recorded as *Aphis populifoliæ* Fitch by Mr. Davis (Journal Economic Entomology, vol. 3, p. 489) as, according to Mr. Baker, *populifoliæ* Fitch belongs under *Pterocomma*.

Prociphilus xylostei de Geer

(Fig. 20, h, i)

A colony of what seems to be the first collection of this species for America was taken from *Lonicera* at Orono, Maine, July 7, 1914. A single stem female with her progeny of pupal nymphs and newly winged spring migrants were collected. The migrants apparently accord in structural characters with specimens of this species taken in Sweden by Albert Tullgren, and seen by the writer, though they are smaller.

Prociphilus approximatus n. sp.

Alate Vivipara: Head with dorsal wax plates large, sub-circular and separated by fully half their width; beak extending to or a little beyond second coxæ, antennal segment III with ± 25 sensoria, IV with ± 8, V with ±12, VI with ±12, IV about as long as tarsus exclusive of claw, shorter than V or VI which are sub-equal, III a little longer than V + VI; thorax with wax plates large, clear cut, approximate, being separated only by a straight line; wings not unusual for this genus; abdomen with large lateral wax plates covering nearly the width of the segment, and large dorsal wax plates.

The cotype material including pupæ and newly molted alates was collected from White Ash, Hawleyville, Connecticut, June 19, 1914, by Dr. W. E. Britton. It is a distinctive species especially with reference to the large approximate thoracic wax plates, and if migratory offers an interesting life-cycle problem.

Lachnus rosæ Cholodkovsky

(Fig. 20, j)

A *Lachnus* which accords too well with the species indicated to entitle it to another name was made July 12, 1915, from wild rose near

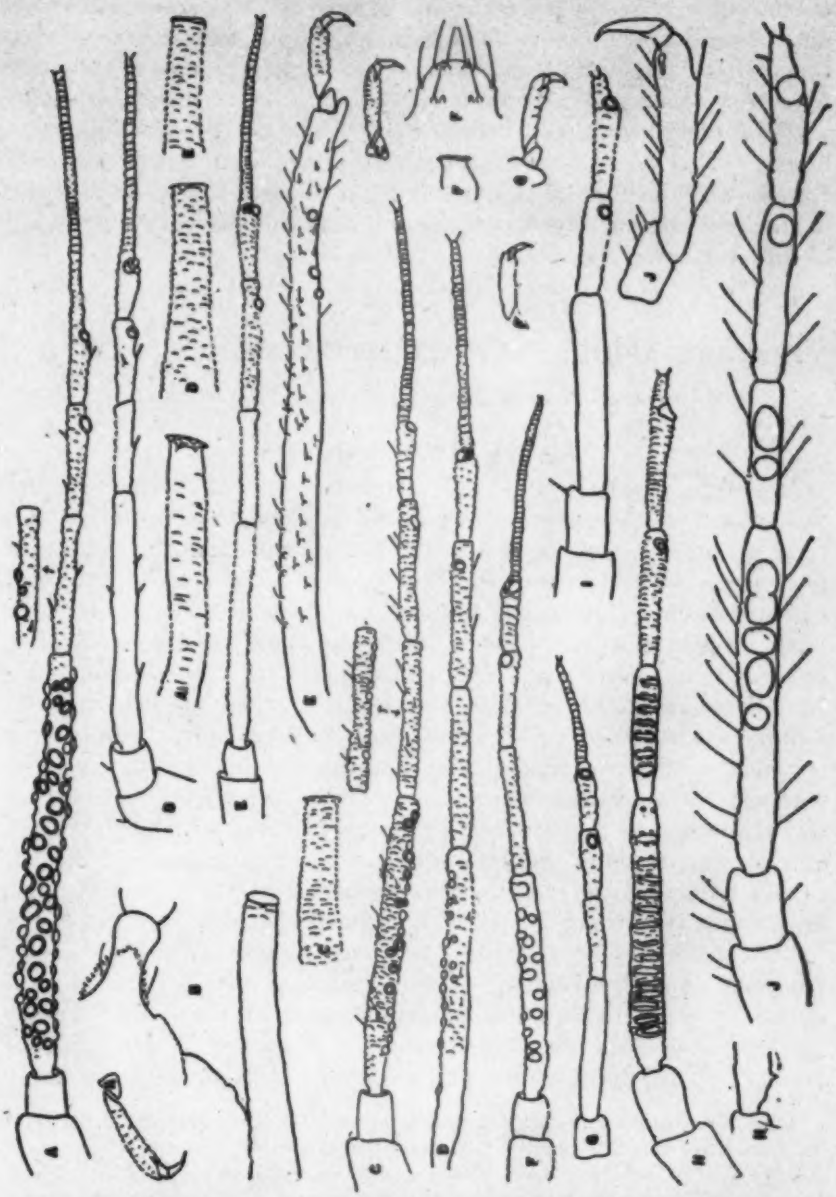


Fig. 20. *A*, *Aphis saliceti*, alate vivipara. *B*, *A. saliceti*, apterous vivipara, *C*, *A. viburniphila*, alate vivipara. *D*, *A. viburniphila*, apterous vivipara. *E*, *A. viburniphila*, apterous ovipara. *F*, *A. rumexicolens*, alate vivipara. *G*, *A. rumexicolens*, apterous vivipara. *H*. *Prociphilus xylostei*, alate vivipara. *I*, *P. xylostei*. apterous vivipara. *J*, *Lachnus rosæ*, alate vivipara.

Orono. The colony was feeding on the stem and was accompanied by ants. Alate and apterous females and nymphs were taken at this time. Later, August 24, in the same locality an apterous female and nymph of this aphid were found. The body of the apterous female was glistening bronze and thickly hairy. The nymph was cinnamon brown. This has not been compared with actual specimens from Russia, but the figures accompanying the original description seem in this case adequate for determination. There is no previous record of this species for America.

EASTERN APHIDS, NEW OR LITTLE KNOWN, PART II

By ARTHUR C. BAKER, *Bureau of Entomology, Washington, D. C.*

GENUS MYZOCALLIS PASS

Myzocallis punctatellus (Fitch). (1855, p. 165.) This species has been placed as a synonym of *caryella* by Oestlund (1887, p. 45). The type specimen which is in the U. S. National Museum collection proves this not to be the case. The type is not in perfect condition, having lost the abdomen, one antennæ, the unguis of the other and both hind wings. However, enough of the specimen remains to make a determination positive and this remnant has been well mounted by Mr. Pergande. The antenna remaining on the type measures as follows: III, 0.592 mm.; IV, 0.496 mm.; V, 0.368 mm. Segment III is armed with seven rather large sensoria forming a row along the segment. The vertex and crown are armed with a number of tubercles on which spines are mounted. The wings are without markings excepting a clouding around the edge of the stigma and bands of brown bordering the veins. This bordering of the veins is rather faint in the type which is no doubt somewhat faded.

Mr. Davis kindly sent me specimens of an undescribed species from the Monell collection. These specimens, No. 370 X, are undoubtedly *punctatellus*. The banding along the veins is more distinct and the specimens are in good shape. They are alate viviparous females. The following description is drawn up from the specimens.

ALATE VIVIPAROUS FEMALE: Antennæ as follows: III, 0.576 mm.; IV, 0.432 mm.; V, 0.336 mm.; VI (0.144 mm. + 0.32 mm.). Segment III, with usually five large circular sensoria in a row. Labium short. Abdomen with two pairs of very prominent finger-like tubercles and with several smaller ones. Length of the larger pair of these tubercles about 0.16 mm. Cornicles about 0.065 mm. Length of fore wing 2.56 mm. Length from vertex to tip of cauda 1.44 mm.

General color pale yellowish. Antennal segments ringed with brown at their distal extremities; tarsi, abdominal tubercles and a spot near the distal extremity of the femora dark brown; wings banded with brown as previously described.

A form occurs in a collection taken on oak at New Haven, Conn., June 27, 1913, by H. L. Trowbridge, on oak, New Haven, Conn., July 25, 1912, by J. K. Lewis, and in a collection taken on oak at Vienna, Va., August 23, 1912, by the writer. This form agrees with the specimens mentioned previously in all details excepting the markings of the wings. It is true that larger or smaller specimens show longer or shorter antennæ, but this might be expected. Among the specimens in these collections great variation is met with in the markings of the wings. In several specimens the markings have a tendency to be arranged along the veins. From this fact and the very close measurements and structural details the writer feels that the specimens may all represent the same species. He is, therefore, calling them *punctatellus*. Abundance of material may, however, prove two species present.

Myzocallis alnifoliæ Fitch. (1851, p. 67.) This species occurs throughout the Eastern States on alder and is recorded in our literature as *alni* Fab. The European insect seems to be different from our form and this is shown particularly in the oviparous female. In specimens of the oviparous female of *alni* determined by Schouteden the third segment of the antennæ is armed with prominent hairs. The other segments sometimes also have them although no sensoria are met with on the antennæ. The hind tibiæ are swollen and covered with numerous sensoria as is usual with many of such forms. *Alnifoliæ* on the other hand has no such prominent hairs on the antennæ of the oviparous forms. The third segment, however, is armed with several sensoria in all adult specimens examined by the writer. These two differences would seem to indicate that the American form is distinct from the European.

The types of *alnifoliæ* have seemingly been lost. It is most probable that they were destroyed during the years between Fitch's death and the time his collection was brought to Washington. In looking over the Fitch collection the writer found the positions in which the specimens were pined, but the specimens have disappeared. It would appear, therefore, that the determination can never be positively proven. The description, however, fits the insect well. In his notes Fitch first described the species as *Aphis alnicolens*, which name he afterwards changed. In his collection there were no specimens bearing this name.

Myzocallis californicus n. sp. Taken on *Quercus lobata* Nee, Walnut Creek, Cal., April 6, 1916, by W. M. Davidson. Although not a Eastern species the present form is here described in order that it may be included in the key of American species of the genus. It seems to be somewhat related to *fumipenellus* Fitch.

ALATE VIVIPAROUS FEMALE: Morphological Characters: Antennæ with the following measurements: Segment III, 0.72 mm.; IV, 0.432 mm.; V, 0.352 mm.; VI (0.144 mm. + 0.16 mm.). Segment III is armed with about 4 circular sensoria considerably separated. Abdomen armed with three pairs of prominent finger-like tubercles tipped with stout hairs. Cornicles rather long and narrow for the genus, 0.112 mm. long. Cauda quite deeply bilobed, suggesting that of *fumipenellus* Fitch; cauda very distinctly knobbed. Length of forewing, 2.4 mm.; length from vertex to tip of cauda about 1.7 mm.

Color Characters: General color pale yellowish green; eyes, distal extremities of the antennal segments, the tarsi, a spot on the proximal extremities of the tibiæ and a small area on each end of the tibiæ brown. Otherwise uniform yellowish green, the eyes of the embryos showing through the abdomen as small red spots.

Described from alate viviparous females in balsam mounts.

Type in U. S. National Museum. Cat. No. 20341.

Myzocallis fumipennellus (Fitch). (1855, p. 166.) This seemingly rare species is known to the writer only from the type now in the National Museum and from the type of *caryæfoliæ* Davis, in the same collection. The two seem to be identical. Fitch's type is not entire but consists of the head and thorax with the third segment of one antenna and part of the other, the wings and the legs. The abdomen of course is shrunken. The parts remaining, however, are very characteristic and leave little doubt that the species described by Davis is the *fumipennellus* of Fitch.

Wilson placed this species in the genus Callipterus as the only American form. It is quite distinct, however, from the type of the genus, and is no doubt a *Myzocallis*. So far as the writer is aware no species of Callipterus occur in this country.

The excellent description given by Davis (1910, p. 198) has placed this species definitely in the literature and it only remains to transfer Fitch's name to his description.

Myzocallis tiliæ (L). Taken on *Tilia*, New Haven, Conn., July 14, 1909, by A. I. Bourne. Conn. No. 1–16/109. This well-known species seems to occur commonly wherever its host tree is grown. The genus Eucallipterus has been erected with this form as type. There is no doubt that the species considered without other forms shows a considerable difference from the type of Myzocallis. Three species might be separated and included in *Eucallipterus; tiliæ* L., *bellus* Walsh and *walshi* Mon. The only real character to separate *tiliæ* is the deeply bilobed nature of the anal plate as compared with the shallow bilobed anal plate of Myzocallis. Some species of Myzocallis, as *trifolii* Mon., often have a distinctly bilobed anal plate. The cauda and anal plate of *bellus* Walsh are very close indeed to those of *tiliæ* and there would be no difficulty in separating these two species from the type of Myzocallis. *Walshi* Mon. is very close in general structure to *bellus* Walsh; so close indeed, that it has by some been placed as a

synonym. Yet when we come to examine the anal plate of *walshi* we find that many specimens show a typical Myzocallis anal plate. The prothorax in *tiliæ* is somewhat different from that of most species of Myzocallis and this is also approached by *bellus* and *walshi*. Yet other species vary toward it. Here then we have the choice of placing *tiliæ* and *bellus* in Eucallipterus and most specimens of *walshi* in Myzocallis or of transferring *tiliæ* to Myzocallis wherein *bellus* was described and the other species since placed. The latter method has been adopted by the writer in that it would seem to simplify matters. The species needs no descriptive remarks since an excellent description has been given by Davis. (1909, p. 33.)

The following key will distinguish the American species of Myzocallis.

KEY TO AMERICAN SPECIES OF MYZOCALLIS

(Alate viviparous females)

1. Dorsum of abdomen with finger-like tubercles 2
   Dorsum of abdomen without such tubercles 7
2. Unguis of segment VI about equal in length to the base 3
   Unguis of VI twice as long as base ..... *punctatellus* (Fitch)
3. Cornicles long (nearly 0.112 mm.) abdomen greenish 4
   Cornicles short (0.064 mm. or less) 5
4. Segment VI less than width of head across eyes ..... *californicus* Baker
   Segment VI much longer than width of head across eyes ..... *pasaniæ* Davidson
5. Segment III of antennæ shorter than the width of head across eyes, abdominal tubercles setose and dark brown; cornicles about 0.06 mm. *fumipennellus* (Fitch)
   Segment III longer than width of head across eyes 6
6. Cornicles about 0.06 mm. long and black ..... *quercus* (Kalt.)
   Cornicles about 0.032 mm. long and not black ..... *ulmifolii* (Mon.)
7. Entire margin of wing with a rather broad dark brown band 8
   Margin of wing without such dark brown band 10
8. Unguis of segment VI more than twice as long as base, hind tibiæ yellowish *walshi* (Mon.)
   Unguis of segment VI less than twice as long as base 9
9. Antennæ distinctly annulated with dark brown; segment III with 10 to 12 oval sensoria, tips of the wing veins marked with brown ..... *tiliæ* (L.)
   Antennæ uniform yellowish or dusky; segment III with about four circular sensoria; tips of wing veins not marked with brown ..... *bellus* Walsh
10. Unguis of segment VI about equal to or less than the length of the base 11
    Unguis of segment VI considerably longer than the base 14
11. Abdomen with a number of dark spots 12
    Abdomen uniform green or yellowish green 13
12. Antennæ annulated, segment III with 4 to 8 sensoria close to base of segment *arundicolens* (Clark)
    Antennæ yellowish or dusky; segment III with a row of 10 or 12 sensoria covering about three-quarters of the segment ..... *trifolii* (Mon.)
13. Anal vein and base of cubitus and of media much heavier than the other veins of the wing ..... *alnifoliæ* (Fitch)
    Venation nearly uniform ..... *robiniæ* (Gill.)

14. Wings more or less banded or mottled with dark brown..... 15
Wings not so banded or mottled..... 16
15. Cornicles and a patch around their bases black.....*discolor* (Mon.)
Cornicles and a patch around their bases yellow.....*asclepiadis* (Mon.)
16. Unguis of segment VI three times as long as base.....*coryli* Gœtz
Unguis of segment VI about twice as long as base..... 17
17. Abdomen with four rows of dark brown markings.....*castanicola* Baker
Abdomen without dark brown markings.....*punctatus* (Mon.)

N. B. *Callipterus genevii* Sanb. is a synonym of *trifolii* Mon.
Callipterus hyalinus Mon. is a synonym of *punctatus* Mon.
Callipterus castaneæ Buckton has been renamed *castanicola* n. n. Baker

Genus Monellia Oest.

Monellia costalis (Fitch). (1855, p. 165.) Taken on hickory leaves, New Haven, Conn., June 27, 1910, by W. E. Britton. Conn. No. 1–16/70.

In order to determine positively whether or not the specimens collected are this species the writer examined the Fitch collection and located the type specimen still bearing the original number mentioned in Fitch's note book. Since there was only one specimen in Fitch's collection and one specimen only referred to in his notes, there can be positively no doubt about this specimen being the type. Descriptive notes follow:

Alate Viviparous Female: Antennal segments as follows: III, 0.352 mm.; IV, 0.256 mm.; V, 0.256 mm.; VI (0.16 mm. + 0.176 mm.). Segment III with five or six oval sensoria on the swollen 0.128 mm. of the segment. Abdomen with three rather large rounded gibbous tubercles on each side of abdomen. Length of forewing 1.144 mm. Length from vertex to tip of abdomen 1.76 mm.

Color yellowish; antennæ yellow ringed with dark brown; vertex lined with dark brown and a line extending down each side from eyes to past the caudal pair of the lateral tubercles mentioned. Fore wings with a broad brown band extending along the costal margin to beyond the stigma, this band interrupted just mesad of the stigma.

Key to the American Species of Monellia

(Alate viviparous females)

1. Costal margin of wing with a broad brown band extending beyond the stigma, tibiæ yellow, antennæ annulated with brown.....*costalis* (Fitch)
Costal margin of wing without such broad band though in some cases with the costal vein brown..... 2
2. Tibiæ, antennæ and costal vein dark brown to black.....*californica* Essig
Tibiæ and costal vein yellowish, antennæ annulated with dark brown..... 3
3. Abdomen with rows of dark brown spots; the unguis of Segment VI of antennæ longer than or equal to the base.....*caryæ* (Mon.)
Abdomen without such spots; the unguis of segment VI of antennæ considerably shorter than the base.....*caryella* (Fitch)

Genus Euceraphis Walker

Euceraphis betulæ (Koch). Taken on Japanese maple, Hartford, Conn. Sept. 11, 1905, by C. N. Ruedlinger, Conn. No. 1–16/145.

This species may be distinguished by the black marking upon the abdomen, the wax pores, the color of the legs and the proportions of the antennal segments and the width of the head.

The abdomen of the alate vivipara is marked with a large quadrate more or less broken dark brown patch. Within this patch there are lighter somewhat oval areas which constitute the wax plates. These areas are composed of small circular pores very variable in number in the different plates. The hind tibiæ are light in color with the distal extremities and tarsi black. The antennal segments measure as follows: III about 1.456 mm.; IV, 1.008 mm.; V, 0.8 mm.; VI (0.256 + 0.256 mm.). The head is about 0.6 mm. in width across the eyes.

Dr. Fitch described a member of the present genus under the name of *Aphis cerasicolens*. (1851, p. 65.) The type of this species is not in good condition. It was mounted from the Fitch collection by Mr. Theo. Pergande. As far as the writer is able to tell from an examination of the specimen this name is a synonym of *betulæ*.

Euceraphis mucidus (Fitch). (1856, p. 334.) Taken on black birch, New Haven, Conn., July 1913. Conn. No. 1–16/19.

The writer has examined the specimens of this species from the Fitch collection and compared them carefully with the Connecticut material and specimens from other regions. He is thus able to give a positive determination.

Alate Viviparous Female. Morphological Characters: Antennæ about as follows though somewhat longer or shorter in larger or smaller specimens. Segment III, 1.984 mm.; IV, 1.408 mm.; V, 1056 mm.; VI (0.448 mm. + 0.384 mm.). Segment armed with a few short, stiff, spine-like hairs. Segment III, with about 30 narrow oblong transverse sensoria upon the basal half of the segment. The extreme basal portion is without sensoria and that part which is covered with sensoria is somewhat swollen. Distal segments rather strongly imbricated; width of the head across the eyes about 0.64 mm.; vertex with a few short spine-like hairs and somewhat projecting forward to the median ocellus but without tubercles or projecting areas above. Cornicles nearly 0.16 mm. long and about 0.117 mm. broad at the base. Anal plate slightly notched; tibiæ very thickly covered with minute subcircular pore-like areas which are hardly as large as the tubercles forming the bases of the hairs on these segments. Dorsum of abdomen without apparent wax gland areas. Length from vertex to tip of cauda 2.88 mm.

Color Characters: Antennæ uniform black. In the pupa some specimens show only the distal segments black. Body pale green. Abdomen without the black markings met with in *betulæ*. Wings transparent, the veins sometimes noticeably dark brown. Stigma bordered below usually with dark brown or black. Femora whitish, tibiæ and tarsi black.

Body covered with a thick powdery material. Legs and sometimes parts of body covered with flocculent mealy down which assists the insect in floating through the air.

Besides the proportions, the distinguishing characters of this species are the uniform black antennæ and the absence of markings upon the abdomen. The most important character, however, is nature of the tibiæ. What appears to be the same species as *mucidus* was described by Fitch as *Aphis pinicolens*. (1851, p. 66.) The type of this species in the U. S. National Museum is in very poor condition. The tibiæ show the large number of minute pore-like structures met with in *mucidus*. The tibiæ, however, are not uniform black as in the type of *mucidus* and in the collected material of that species. Only their tips are dark brown. This may be due to the fading of the type specimen. No collected specimens which agree in all details with this type of *pinicolens* have been seen by the writer. He therefore withholds judgment in regard to the use of the name *pinicolens*.

Euceraphis brevis n. sp. Taken on "cut-leaf" white birch, Middletown, Conn., May 3, 1906, by Morris B. Crawford, Bureau of Entomology No. 9541, and on Betula sp., Ithaca, N. Y., May 15, 1911 by E. M. Patch, Me. Exp. Sta. Acc. No. 20–11.

ALATE VIVIPAROUS FEMALE: Morphological Characters: Antennal segments as follows: III, 1.2 mm.; IV, 0.672 mm.; V, 0.528 mm.; VI, (0.176 + 0.128 mm.). Segment III, with 18 or 20 sensoria close together upon the basal third of the segment. Distal segments imbricated; width of head across the eyes about 0.64 mm.; vertex with two slight projections above abdomen with large lateral protuberances. Cornicles about 0.128 mm. long. Anal plate entire; length from vertex to tip of cauda 2.4 mm.

Color Characters: General color greenish; antennæ shaded with dusky becoming black on the distal segments; legs with the tarsi and distal extremities of the tibiæ black. The distal extremities of the femora are also sometimes more or less black.

Described from alate viviparous females in balsam mounts.
Type in U. S. National Museum. Cat. No. 20342.

Euceraphis lineata n. sp. Taken on birch at Durham, N. H., Oct. 19, 1903, by C. M. Weed, Bureau of Entomology No. 9315 D., and on *Betula populifolia*, Orono, Me., July 21, 1906, by E. M. Patch, Me. Acc. No. 83–06.

ALATE VIVIPAROUS FEMALES: Morphological Characters: Antennæ with the following measurements: Segment III, 1.68 mm.; IV, 1.36 mm.; V, 0.928 mm.; VI (0.096 mm. + 0.4 mm.). Segment III with about 25 sensoria on the basal 0.64 mm. Width of head across the eyes 0.64 mm.; vertex without projections, antennæ rather close together. Length from vertex to tip of cauda 3.12 mm.; length of forewing 4.5 mm.; anal plate rounded or very slightly indented.

Color Characters: General color greenish yellow; antennæ dusky with blackish distal annulations on the segments; tarsi, distal extremity of labium and distal extremity of the femora and tibiæ dark brown. The tibiæ has, moreover, a longitudinal dark brown stripe extended for nearly its entire length. Abdomen without dark brown markings but with the eyes of the young showing as dark brown spots.

Described from specimens in balsam mounts.
Type in U. S. National Museum. Cat. No. 20343.

Euceraphis deducta n. sp. Taken on birch, Orono, Me., June 12, 1907, by E. M. Patch, Me. No. 4–07.

This species is easily distinguished from all others in the genus by the proportions of segment VI of the antenna.

ALATE VIVIPAROUS FEMALE: Morphological Characters: Segment III, 1.68 mm.; IV, 0.88 mm.; V, 0.8 mm.; VI (0.48 mm. + 0.144 mm.). Segment III, with about 20 sensoria on the basal 0.56 mm. Width of head across the eyes 0.64 mm. Cornicles and anal plate normal for the genus. Length from vertex to tip of cauda 2.4 mm. Length of forewing 3.52 mm.

Color Character: Color apparently a uniform yellowish green. Antennæ, tips of femora and tibiæ and the tarsi dusky. Eyes dark brown; wings unmarked excepting the tips of the veins which are shaded with brown.

Described from specimens in balsam mounts.

Type in U. S. National Museum. Cat. No. 20344.

The following key will distinguish the American species of Euceraphis.

KEY TO THE AMERICAN SPECIES OF EUCERAPHIS

(Alate viviparous females)

1. Anal plate distinctly but not deeply bilobed. Segment III of antennæ with eight or nine sensoria ..... *flava* Davidson
   Anal plate entire or but slightly indented 2
2. Tibiæ uniform black and covered thickly with a large number of small clear pores ..... *mucidus* (Fitch)
   Tibiæ not uniform black and without such pores 3
3. Abdomen with a large dark brown patch in which are clear wax pore areas ..... *betulæ* (Koch)
   Abdomen without such dark patch and wax pore areas 4
4. Combined length of base and unguis of segment VI about equal to half of the diameter of the head across the eyes ..... *brevis* Baker
   Combined length of the base and unguis of segment VI about equal to or much more than the diameter of the head across the eyes 5
5. Unguis of segment VI less than one third of the length of the base .... *deducta* Baker
   Unguis of segment VI considerably more than two-thirds as long as the base ... 6
6. Hind tibia with a longitudinal black stripe on its outer edge; segment III with about twenty-five sensoria ..... *lineata* Baker
   Hind tibia with only the distal extremity black and segment III with about fifteen sensoria ..... *gillettei* Davidson

GENUS CALLIPTERNELLA Goot.

Callipternella annulata (Koch). Taken on *Betula populifolii* at Veazie, Me., by E. M. Patch, July 22, 1909. Maine No. 82–09. On white birch, New Haven, Conn., July 7, 1909, by A. I. Bourne, Conn. No. 1–16/142. On birch, New Haven, Conn., by A. B. C., June 28, 1911, Conn. No. 1–16/18 and on birch at Madison, Wis., by J. J. Davis, June 7, 1913. What is evidently the same species was mentioned by Gillette (1910) as occurring upon Birch. Vander Goot (1913, p. 113) has placed this form as the same species as *annulatus* Koch.

ALATE VIVIPAROUS FEMALE: Morphological Characters: Antennæ measurements as follows: I, 0.08 mm.; II, 0.048 mm.; III, 0.48 mm.; IV, 0.288 mm.; V, 0.176 mm.; VI, (0.096 + 0.24 mm.). Segment III, armed with from 5 to 7 circular sensoria in an even row on the basal two-thirds of the segment. The sensorium at the base of the unguis of VI, rather elongate, all permanent sensoria fringed; vertex somewhat protruding and armed with prominent hairs about 0.08 mm. long. Cornicles about 0.08 mm. long, distinctly imbricated but not reticulated. Wings usual, forewing about 2 mm. long and with the radial sector faintly indicated or almost absent. Length from vertex to tip of cauda about 1.54 mm.

Color Characters: Antennæ yellowish with the base, the distal segments and the distal extremities of III and IV brown; legs, cornicles, transverse bands and lateral spots on the abdomen dark brown to black. Wing veins faintly bordered with dusky; stigma dusky with a clear central area.

APTEROUS VIVIPAROUS FEMALE: Morphological Characters: Antennal measurement as follows: I, 0.064 mm.; II, 0.048 mm.; III, 0.48 mm.; IV, 0.24 mm.; V, 0.224 mm.; VI (0.096 + 0.304 mm.). Segment III, with about 8 circular sensoria in a row on the basal two-thirds of the segment. Hairs on the vertex about 0.15 mm. long. Cornicles about 0.096 mm. long, imbricated, not reticulate. Length from vertex to tip of cauda about 1.92 mm. Abdominal hairs of about equal length with those on the vertex. Dorsum of abdomen covered with minute projections giving it an almost granular appearance.

Color Characters: General appearance dark brown. Antennal segments III and IV with dark distal extremities, the distal portions of the antennæ entirely dark. Legs dark brown. Head and thorax with large dark brown area. Abdomen marked with large dark brown lateral patches and with transverse dorsal bands of dark brown one on each segment. Remainder yellowish.

GENUS CHAITOPHORUS Koch.

Chaitophorus lyropicta Kess. Taken on the Norway maple, Meriden, Conn., June 26, 1912, by Louis A. Guidebrod. Conn. No. 1–16/14.

This species is abundant upon the Norway maple throughout the eastern section of the United States. The insect is usually considered in America under the name of *aceris*. It may be distinguished by the proportions of the sixth segment of the antennæ. The species varies considerably in size; the antennæ of the alate vivipara averaging about as follows: III, 0.592 mm.; IV, 0.368 mm.; V, 0.32 mm.; VI (0.112 mm. + 0.512 mm.). Segment III is armed with a more or less even row of from 4 to 9 sensoria.

So far as the writer has been able to discover this species never produces dimorphs.

Chaitophorus americanus n. sp. Taken on sugar maple, Brookfield Center, Conn., May 10, 1913, by C. Holder; Conn. No. 1–16/13, on *Acer* sp., Orono, Me., June 1, 1909, by E. M. Patch; Me. No. 18–09 on *Acer circinatum* at Hoquiam, Wash., June 1903, by A. D. Hopkins and on the same tree at Hoquiam, Wash., August 1903, by H. E. Burke, Bureau of Entomology, No. 9797.

There seems to have been considerable confusion in regard to the species of Chaitophorus producing dimorphic forms. Two species

occur in Europe and two in America. The European species are *aceris* L. and *testudinatus* Thorn. Of these the latter species has dimorphs margined with lamellæ whereas the dimorphs of *aceris* are armed only with long stout hairs. The two species in this country *negundinis* Thos., and the present one both have dimorphs margined with lamellæ. *Negundinis* is found upon the Manitoba maple (*Acer negundo*), whereas *americanus* feeds on the trees mentioned previously. The two species are easily distinguished.

ALATE VIVIPAROUS FEMALE: Morphological Characters: Antennæ showing considerable variation, but being about as follows: Segment III, 0.72 mm.; IV, 0.44 mm.; V, 0.34 mm.; VI (0.128 mm. + 0.368 mm.). Segment III, armed with from 18 to 24 irregularly placed sensoria which often give the segment a more or less swollen appearance. Antennal hairs long and prominent; about 0.16 mm. on Segment III. Cornicles about 0.24 mm. long and covered with reticulate areas; length from vertex to tip of cauda 3.1 mm.

Color Characters: General color dark green. Head, antennæ, thoracic lobes, sternal plate and cornicles black. Abdomen with a row of transverse black bands on the dorsum and with a row of more or less circular black spots along the margin.

DIMORPH: Morphological Characters: Antennal segments as follows: III, 0.16 mm.; IV (0.064 mm. + 0.24 mm.). First segment large, projecting forward; vertex and entire margin of the body with the exception of the lateral margins of the head covered with a row of lamellæ. On the lateral margins of the head the lamellæ are replaced by lanceolate spines. Similar spines also occur upon the outer margins of the legs; dorsum apparently without plate-like structures.

Color Characters: Pale greenish with red-brown eyes.

Described from specimens in balsam mounts. Type in U. S. National Museum. Cat. No. 20345.

Chaitophorus viminalis Mon. (1879, p. 31.) Taken on *Populus grandidentata*, New Haven, Conn., June 29, 1914, by M. P. Zappe. Conn. No. 1–16/24.

A study of the type of this species kindly sent to the writer by Mr. J. J. Davis, and numerous specimens from different localities proves that the species always possesses a granular surface on the skin, although this granulation varies considerably in degree. The color also varies from a light green to a dark brown.

Chaitophorus nigræ Oest. (1887, p. 40.) Taken on willow at Galesville, Conn., July 15, 1909, by B. H. Walden. Conn. No. 1–16/125.

In studying a series of specimens thought to be this species it was noted that the reticulate marking of the skin was a constant character. Professor Oestlund kindly examined his type and informed the writer that this character is present in the type. It seems, therefore, that *nigræ* may be separated from *viminalis* on this character and on the sensoria. The type of *cordata* Wms., proves it to be the same species.

Chaitophorus bruneri Wms. (1910, p. 25.) Taken on poplar,

New Haven, Conn., July 8, 1909, by A. I. Bourne. Conn. No. 1–16/132.

This species is very close indeed to *populicola* Thos., as that insect is at present understood. A large series of the latter species shows considerable variation and a more thorough study should be made of bred material. The co-types of *bruneri* in the National Museum collection consist of alate forms and apterous females. The principal differences noted between these types and the average specimens of *populicola* are, apart from the size, the antennæ and the body hairs. Segment IV of the alate form has no sensoria or one, whereas in the same segment of *populicola* there are usually several. In many cases, however, this segment in specimens of *populicola* shows only one sensorium. The apterous specimens of *bruneri* on the Connecticut slide, as well as one specimen on the type slide, show hairs which are stout and notched at the tip. This character is also shown in a collection taken for *populicola* in Minnesota. All the other material of *populicola* which the writer has examined shows long normal hairs. This character of the hairs showing in such few specimens may possibly be a specific indication but the writer retains *bruneri* not on the strength of these hairs, but on account of a lack of material suitable for dissection and study in order to fix its status. The following measurements have been made from the cotypes in the National Museum collection.

ALATE VIVIPAROUS FEMALE: Antennæ as follows: Segment III, 0.416 mm. with 17 sensoria; IV, 0.224 mm.; V, 0.208 mm.; VI (0.128+0.16 mm.), Cornicles 0.112.

APTEROUS VIVIPAROUS FEMALE: Antennal segment III, 0.368 mm.; IV, 0.208 mm.; V, 0.208 mm.; VI (0.112 mm. + 0.144 mm.).

KEY TO THE AMERICAN SPECIES OF CHAITOPHORUS

(Alate viviparous females)

1. Wing veins heavily bordered with dark brown 2
   Wing veins not heavily bordered with dark brown 4
2. Antennæ with very few hairs (apterous form with thick spines) ... *quercicola* (Mon.)
   Antennæ noticeably hairy 3
3. Segment III of antennæ usually with several sensoria (apterous form with straight spine-like hairs) ..... *populicola* Thos.
   Segment III of antennæ usually with one sensorium (apterous form with notched spine-like hairs) ..... *bruneri* Wms.
4. Feeding upon species of maples 5
   Feeding upon species of willow and poplar 7
5. Segment III of antennæ with 16 to 24 sensoria somewhat irregularly placed on the basal three quarters of the segment ..... *americanus* Bkr.
   Segment III of antennæ with 4 to 9 sensoria in a more or less even row 6
6. Unguis of segment VI less than three times as long as the base .... *negundinis* Thos.
   Unguis of segment VI much more than three times as along as the base, often more than four times as long ..... *lyropicta* Kess.
7. Vertex and crown covered with reticulate areas (dorsum of apterous form reticulate) 8

Vertex and crown without reticulations but these replaced by granulations (especially on apterous form) Segment IV with 0 to 2 sensoria.... *viminalis* Mon.

8. Segment IV with 4 to 6 sensoria..... *nigræ* Oest.
Segment IV with no sensoria..... *salicicola* Essig

N. B. *Chaitophorus agropyronensis* Gillette is a species of *Sipha*
Chaitophorus flabellus Sanborn is a species of *Saultusaphis*
Chaitophorus betulæ Buckton of Gillette is a species of *Callipterniella*
Chaitophorus artemisiæ Gillette seems to be the same form described as *Cryptogeiphum canadensis* by Williams. It is not a Chaitophorus.
Chaitophorus spinosus Oest., is a synonym of *quercicola* Mon.
Chaitophorus cordata Wms., is a synonym of *nigræ* Oest.
Chaitophorus stevensis Sanborn is a synonym of *viminalis* Mon.
Chaitophorus delicata Patch is known only from the apterous forms and is therefore not included in the key
Chaitophorus tridentata Wlsn., the writer has not seen.

Genus Pterocomma Buckton

Pterocomma media n. sp. Taken on poplar, Manchester, Conn., Sept. 3, 1909, by A. I. Bourne Conn. No. 1–16/126 and on Carolina poplar, New Canaan, Conn., Sept. 21, 1909, by A. I. Bourne, Conn. No. 1–16/127.

Alate Viviparous Female: General appearance similar to *beulahensis* Ckll., from which it differs chiefly in the antennæ and cornicles. Antennæ as follows, III, 0.56 mm.; IV, 0.32 mm.; V, 0.272 mm.; VI (0.16 mm.+0.192 mm.). Segment III is covered with a large number of rather small circular sensoria; more distal segments without sensoria. Cornicles 0.256 mm. long, slightly stouter than those of *beulahensis*, being about 0.096 mm. in their greater diameter. They are flanged and somewhat swollen in the middle. Length of forewing 4.28 mm. Hind tarsus 0.24 mm. long, labium extending to the hind pair of coxæ. Length from vertex to tip of cauda about 3 mm. The color characters cannot be obtained from the mounted specimens and no color notes were taken.

Apterous Viviparous Female: Antennal segments as follows: III, 0.544 mm.; IV, 0.256 mm.; V, 0.24 mm.; VI (0.144 mm. + 0.176 mm.). Segments without sensoria. Cornicles 0.256 mm.; hind tarsi 0.24 mm. Labium extending almost to hind pair of coxæ; length from vertex to tip of cauda about 3 mm.

Described from specimens in balsam mounts.
Type in U. S. National Museum. Cat. No. 20346.

Key to the American Species of Pterocomma
(Alate viviparous females)

1. Cornicles without a distal flange and abruptly constricted at the distal extremity..... *flocculosa* (Weed)
Cornicles with a distal flange and not so abruptly constricted at their distal extremities..... 2
2. Cornicles about twice as long as their greatest diameter..... *smithiæ* (Mon.)
Cornicles much more than twice as long as their greatest diameter..... 3
3. Cornicles about equal in length to the hind tarsi..... 4
Cornicles much longer than the hind tarsi..... 6
4. Cornicles cylindrical, beak long..... *populea* (Kalt.)
Cornicles somewhat swollen, beak short..... 5

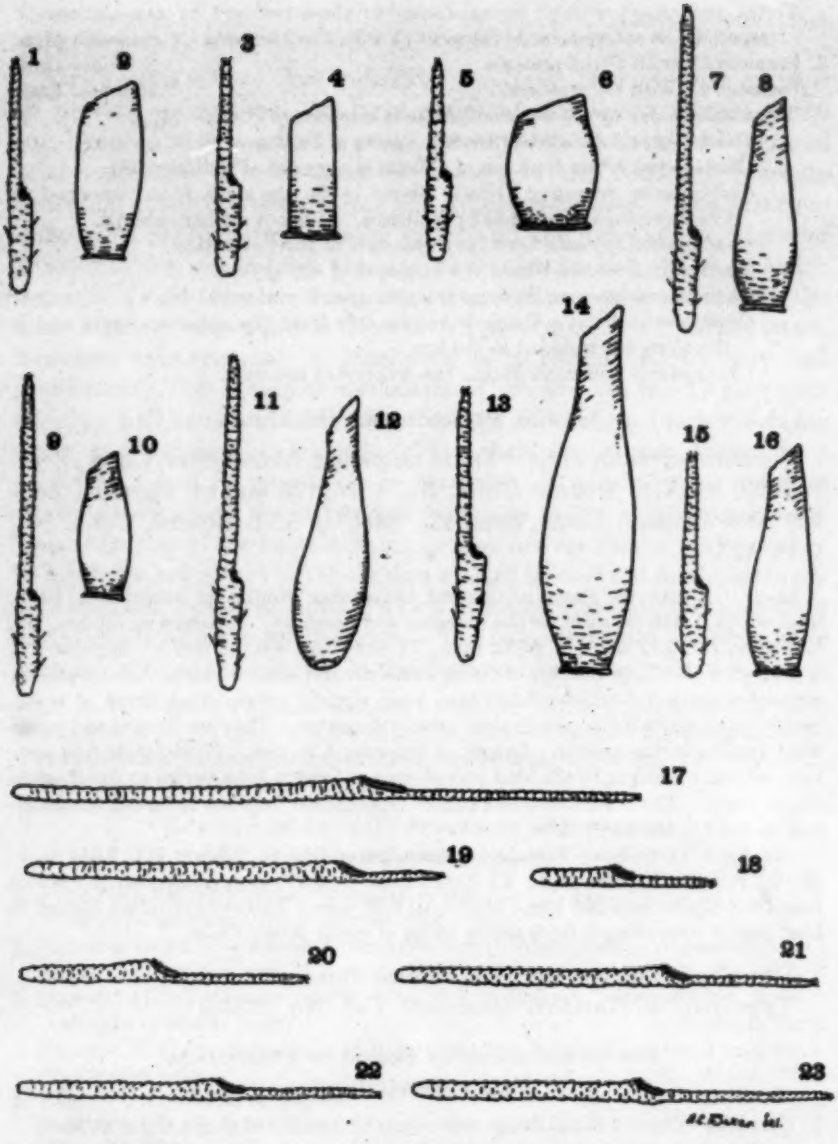


Fig. 21. *Pterocomma media*. 1, distal segment of antenna. 2, cornicle. *P. populea*. 3, distal segment of antenna. 4, cornicle. *P. smithiæ*. 5, distal segment of antenna. 6, cornicle, *P. bicolor*. 7, distal segment of antennæ. 8, cornicle. *P. beulahensis*. 9, distal segment of antenna. 10, cornicle. *P. flocculosa*. 11, distal segment of antenna. 12, cornicle. *P. salicis*. 13, distal segment of antenna. 14, cornicle. *P. populifoliæ*. 15, distal segment of antenna. 16, cornicle. *Euceraphis lineata*. 17, distal segment of antenna. *E. brevis*. 18, distal segment of antenna. *E. deducta*. 19, distal segment of antenna. *E. betulæ*. 20, distal segment of antennæ. *E. mucida*. 21, distal segment of antenna. *E. flava*. 22, distal segment of antenna. *E. gillettii*. 23, distal segment of antennæ. All figures drawn to the same scale.

5. Unguis of segment VI about twice as long as the base.....*beulahensis* (Ckll.)
Unguis of segment VI one and one-half times as long as base.....*media* Baker
6. Cornicles nearly twice as long as the hind tarsi..... 7
Cornicles much more than twice as long as the hind tarsi..... 8
7. Unguis of segment VI of antennæ about equal in length to the cornicles and about twice as long as base.....*bicolor* (Oest.)
Unguis of segment VI of antennæ considerably shorter than the cornicles and not twice as long as base.....*populifoliæ* (Fitch)
8. Cornicles swollen in the middle, bright orange in color.....*salicis* (Linn.)

N. B. *Melanoxantherium antennatum* Patch is known only from the oviparous female.

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THE TOMATO AND LAUREL PSYLLIDS

By E. O. Essig, *University of California, Berkeley, Cal.*

Psyllids are also known as jumping plant-lice because of their great similarity in appearance and habits to these insects and their ability to jump freely. The family *Psyllidæ* to which psyllids belong is usually placed next to the family *Aphididæ* (plant-lice), in the suborder *Homoptera* and the order *Hemiptera*. In this order are to be found many of the insects which are very injurious to crops grown in California.

There have been about fifty species described in California so it will be seen that they are not nearly as abundant as either plant-lice or scale insects. None of the native species have become of great economic importance and but one injurious species has been imported into the state.

Two species, at least, the tomato psyllid, a native of the western states, and the laurel psyllid, a native of Europe, are deemed of sufficient importance and interest to warrant a discussion of this kind.

The Tomato Psyllid

Paratrioza cockerelli (Sulc)

(Plate 20, fig. 1 and fig. 22)

This insect has been of some economic importance in Colorado for a number of years and still continues to receive consideration from agriculturists of that state. In California it is widely distributed and though little has been known regarding its economic status, it is coming to be noticed as a garden and field-crop pest in many localities. While it cannot be classed as an insect of major economic importance or even one which may ever cause great losses, it often increases in sufficient numbers to injure the infested plants and becomes a source of loss and worry to the grower.

General Appearance

Eggs (Fig. 22 D).—The eggs are exceedingly small, elongated-oval, with the attached and decidedly pointed end supported by a short petiole and the free end broadly rounded. The color is transparently white or pale greenish-yellow with a more or less definite orange-colored mass at the middle or base. The surface is normally entirely covered with a fine white powdery wax which gives a decidedly gray appearance. The powdery wax is also deposited over the surface of the leaves around the eggs and materially aids in locating them. The average length is about 0.08 mm. They are usually deposited in very great numbers upon the under surfaces of the older well-matured leaves and stand erect or slightly leaning.

Nymphs (Pl. 20, fig. 1, fig. 22 G).—The first born nymphs are very small and transparently pale yellow with orange-colored head and abdomen. The color changes somewhat as the insects mature and when ready for the last molt they are pale greenish-yellow with gray and orange markings on the dorsum. Excepting for the fringe of scale-like spines around the margins (Fig. 22 H) the bodies are perfectly naked. The bodies are very flat, broadly oval and held close to the surface of the leaves when feeding. The excrement is in the form of minute white pellets of honey-dew (Pl. 20, fig. 1) which are

deposited in sufficient numbers to serve as a ready means of locating an infestation. A slight smutting also accompanies the attacks.

ADULTS (Fig. 22 A). The mature insects are first pale green or light amber but soon become darker, there being a considerable variation in the degree of intensity of the colors. Normally the color is light amber-brown with numerous very dark brown or black markings as shown in the accompanying drawing. A very conspicuous white powdery stripe extends across the dorsal base of the abdomen, and a somewhat definite horse-shoe shaped and quite large area of the same color and covered with fine white powder occurs on the dorsal posterior two thirds of the abdomen. The legs are light amber and sparsely hairy. At the tip of the hind tibiæ there are two apical dark spines on the inside and one on the outside (Fig. 22 C). The antennæ (Fig. 22 I, J) are ten-jointed and dusky, excepting the first three and the basal half of the fourth joints. In many individuals the bases of all the joints excepting the last two are yellow. On the fourth joint near the tip is located a circular sensorium with a peculiar lid or operculum, as shown in Figure 22 B, I, while on each of joints six, eight and nine there is a single simple circular sensorium near the tip. The writer is unable to locate the one on joint two as reported by Sulc. The average length of the body is about 1.8 mm.

TECHNICAL DESCRIPTION

The original technical description as given in English by Dr. Karel Sulc is as follows:

Head.—Breadth of the vertex behind the eyes, 0.34 mm., with the eyes 0.52 mm., the length along the middle-line 0.16 mm., posterior margin of the vertex regularly and slightly excised, posterior angles slightly truncate, the anterior ones broadly rounded; a median line divides the vertex in two halves, either showing a distinct fovea in the middle. Antennæ filiform 1 mm. long in all; the length of single joints is: of the 1st, 2nd, 9th, and 10th 0.05 mm., of the 3rd 0.18 mm., 6th 0.13 mm., 7th 0.15 mm., and 8th 0.12 mm.; smell-organs [sensoria] present on the joints 2, 4, 6, 8, 9; that on the 4th joint is very peculiar being in the form of a hollow ball with a circular opening covered with a spoonshaped movable operculum; the other smell-organs show the form of simple pits. The 3 basal joints of the antennæ are yellow, the 4th–8th yellow, brown at their ends, the 2 last black. Frontal lobes very short, 0.06 mm. only long, rounded at the apex. Clypeus in the form of a pearhalf and not produced anteriorly. Colors of the head: the ground yellow-white, in the middle of the vertex a horseshoe-shaped large brown spot, the middle line of the vertex and the frontal lobes dark brown, the apex of the latter being lighter, clypeus yellowish-white.

Thorax: the ground color white-yellowish with a large, well defined brown marking.

Elytræ: length 2.60 mm., greatest breadth 1.00 mm.; apex in the cell. marg. I., nearly at the end of M_{1+2} and forming an acute angle; the anterior part of its margin being a little shorter than the posterior one. C+Sc, R moderately arcuate, R sinuate, ending at the beginning of the second third of M_{1+2}: M slowly arcuate with its apex

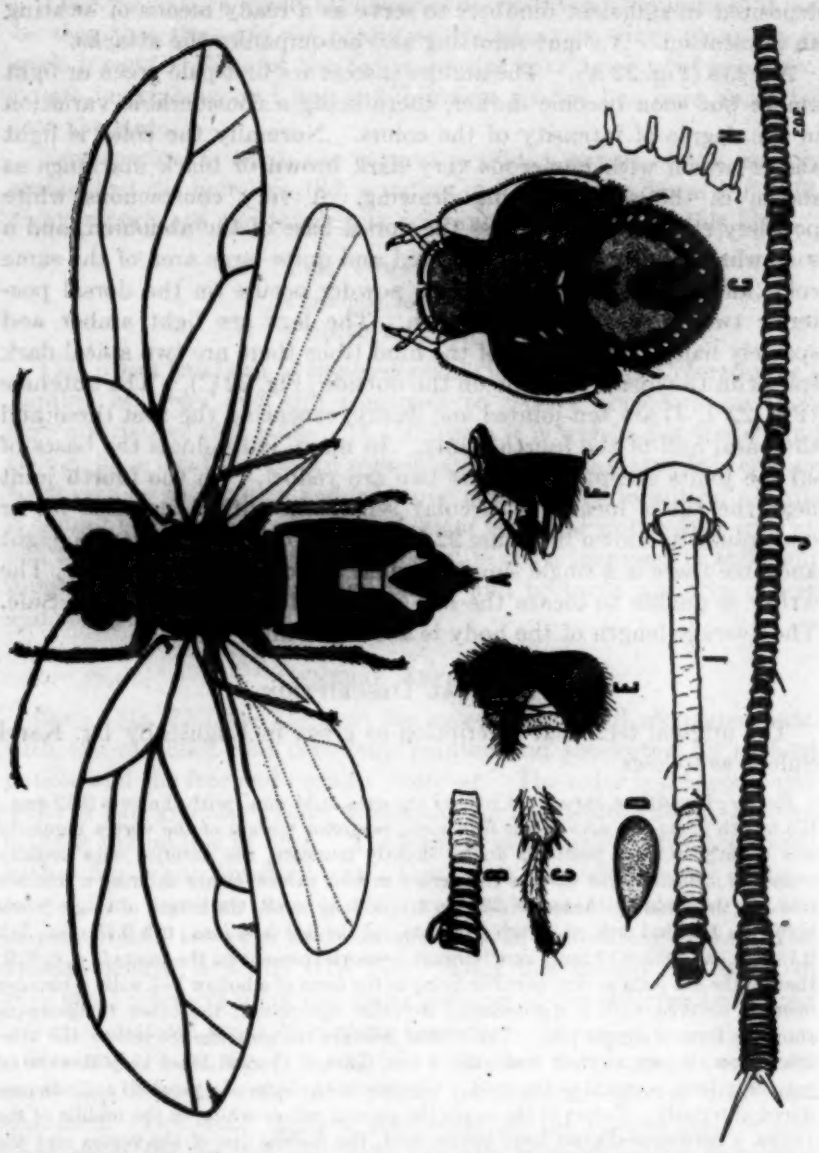

Fig. 22.—The tomato psyllid, *Paratrioza cockerelli* Sulc. *A*, adult female with wings spread; *B*, fourth joint of the antenna showing sensorium with covering or operculum; *C*, tip of the tibia showing apical spines, *D*, egg; *E*, genitalia of the male; *F*, genitalia of the female; *G*, nymph; *H*, fringe of spines around margin of nymph's body (greatly enlarged); *I*, first four joints of the antenna; *J*, last six joints of the antenna. Much enlarged. (Original).

before the middle; M_{1+2} parallel with the wing-axis M_{3+4} almost straight, Cu_1 evenly arcuate. Nervature fine, white yellowish, transversal nervules colorless. Membrane vitreous. No spines on either side of the elytra-membrane; the marginal spines only present and very distinct, forming very narrow, high groups in the cell, Rs, M_{1+2}, Cu.

Hind-wings and legs as usual in the genus.

Apex of the male abdomen: genital segment of equal breadth and height, 0.17 mm.; its posterior and inferior margin evenly arcuate, anterior half of the upper side moderately arcuate; no tubercles; hairs of moderate size, equally scattered on the surface. Color black. Forceps shows the form of a scythe with its edge anteriorly; posterior margin straight, the anterior sinuate; height 0.17 mm., breadth 0.04 mm.; if viewed from behind has the forceps also the form of a scythe, but its edge is turned inwardly and bears at the base a small obtuse tooth; above are the ends of the forceps curved like cattlehorns; hairs equally scattered on the surface. Color brownish. Anal segment 0.17 mm. high, produced posteriorly in a triangular lobe; very long setæ especially on its distal end; color brown.

Apex of the female abdomen. Anal segment viewed from above short, triangular, obliquely truncate at the end; viewed laterally on a preparate boiled in KOH and mounted in glycerin 0.28 mm. long by 0.12 mm. high; its upper margin slightly arcuate rounded at the end; inferior margin straight, slightly excised before the apex; long hairs scattered on the sides, on the upper margin and just under it short, strong, acute spiniform hairs, before the apex a few long, stout and around the anus short little hairs; on the whole surface of the segment very small, short, acute spines in rows parallel with the superior margin.—Anus O-shaped; upper length 0.20 mm., under-length 0.15 mm.; hinder-length 0.24 mm.; apex short acute, its inferior margin straight, the whole surface of the side with long scattered hairs, the hinder half of it with very short, small, acute spines in rows parallel with the posterior margin. External sheath narrowing behind with roundly truncate apex, reaching over the end of the anal segment. The inner stylets straight, obliquely truncate on the underside before the apex; the apex itself acute with two triangular teeth above. The innermost stylets triangular on their end. Color of the anal and genital segments dark brown, sometimes with a few whitish spots.

Length 2–5.3 mm. to the end of closed wings.[1]

Life-History

The winter is passed in the adult stage on evergreen food plants or in sheltered places elsewhere. Eggs are laid late in April and until late fall and early winter in the mild climate of this state. The broods are exceedingly uneven and all stages of the insect may be found from May until the middle or even the last of November. The average length of time required from egg to adult and the number of broods a year are very difficult to fix because of the great amount of variation and uncertainty due to differences in seasons and the difficulty in determining the same. However, there are from three to many overlapping broods each year.

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[1] Sulc, Karel, Acta Soc. Ent. Böhemiæ, VI, pt. 4, pp. 105–108, 1909.

Distribution

As previously stated, this insect has a wide distribution in California. It has been taken in great numbers in Alameda County and received from Eldorado County by the writer and has been reported by others from Los Angeles, Inyo (Death Valley and Argus Mountains), Imperial and San Luis Obispo Counties in California and also from the states of Colorado, Utah, Arizona and New Mexico.

Food Plants

The food plants are only imperfectly known and include in California, the following: Alfalfa (Imperial County), tomatoes (San Luis Obispo County), spruce (Los Angeles County), *Pinus monophylla* Torr. (Argus Mountains, Inyo County) as reported by Crawford, and on the following plants on the campus of the University of California, Berkeley Alameda County, by the writer: tobacco, petunia, *Solanum marginatum* Linn., S. *verbascifolium* Banks, *Datura sanguinea* R. &. P., and *Iochroma tubulosa* Benth. It was also received from Placerville, Eldorado County, where it was abundant on potatoes. In Colorado it was first taken on cultivated pepper and later on tomato and common nightshade (*Solanum nigrum* Linn.). In Arizona Crawford lists it on arborvitæ and *Pursia* sp.

Control

Though unprotected and comparatively delicate, this insect is not at all easy to control. At least two factors enter into this: its fondness for the undersides of the older leaves near the ground where it is well protected from sprays, and the delicate nature of the food plants which will not permit the use of a strong spray of any kind. The first factor can only be overcome by very great care in applying the remedy and the second by the use of tested materials. The oil and soap sprays are specially to be avoided as they seem to be particularly destructive to solanaceous plants and are not recommended unless used in very diluted proportions and then only after experimenting on a few plants. Nicotine sulphate or black leaf forty may be used with comparative safety at the rate of from 1 to 1,000 to 1 to 1,500. Prof. C. P. Gillette writes that in Colorado, several remedies have been studied, especially on tomatoes, and only lime-sulphur proved successful. The commercial product was used in the proportions of 1 to 40 and killed the psyllids without serious injury to the plants. A spray of about the same strength has been used experimentally in spraying potatoes for fungous diseases, but proved to be positively harmful to the crop.[1]

[1] Stewart, F. C. and French, G. T., Bul. No. 347, N. Y. Agrcl. Exp. Sta., pp. 79, 81, March, 1912.

All experiments with lime-sulphur should be first tested on a small scale before extensive applications are made. Fortunately, the insect in question seldom if ever deserves control measures in this state.

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Paratrioza ocellata Crawford, Pomona Jr. Entom. II, No. 2, p. 229, May 1910; also Pomona Jr. Entom. III, No. 1, pp. 447–448, Feb. 1911 (5 figures).

Paratrioza pulchella Crawford, Pomona Jr. Entom. II, No. 2, p. 229, May 1910; also Pomona Jr. Entom. III, No. 1, p. 447, Feb. 1911 (Synonym of *Paratrioza ocellata* Crawf.).

The Laurel Psyllid

Trioza alacris Flor

(Plate 20, figs. 3, 4 and fig. 23)

The laurel psyllid has been the cause of considerable loss to nurserymen in the San Francisco Bay region and has received the attention of local authorities since 1911 when it was first discovered. It was evidently imported from Europe where it has been known as a pest for many years. As an enemy of the laurel it is very pernicious and not only disfigures the foliage, but causes smutting and greatly stunts the plants. Its presence means continued and expensive control measures or very unsightly trees if nothing is done. As the laurel is a favorite ornamental tree and grown generally throughout the state, anything that tends to make it less beautiful should be known and its further dissemination avoided.

Though the known distribution[1] is limited it cannot be long confined to its present areas. Local horticultural authorities are endeavoring to prevent its spread and they are doing much in this direction, but there must be more than local action to make a safe guarantee to the rest of the state. It is sincerely hoped that the few small infestations might be entirely stamped out while this is still possible, before they become too large.

[1] Since preparing this description the author has received specimens of the adults, nymphs and work of this insect on *Laurus nobilis* from Dr. A. G. Smith of Pasadena, California. This is the first record from the southern part of the state and indicates the possible establishment elsewhere in the state.

Sept. 29, 1916.

General Appearance

Eggs (Fig. 23 D).—The eggs are very pale yellow or transparently-white with a darker yellow or orange-colored area near the tip. The entire surface is covered with a very fine whitish powder which gives a grayish color. The shape is elongate-oval with a pointed base and short stipe which is attached to the leaves and a broadly rounded top. The length averages about 0.07 mm.

Nymphs (Pl. 20, fig. 4 and fig. 23).—The nymphs are pale yellow or partially orange-colored and are covered with a thick white cottony wax which is unevenly arranged and entirely hides the body. The naked bodies are rather slender and only about 2 mm. long while with the covering they appear decidedly wide and from 3 to 4 mm. long. When ready to emerge as adults the nymphs leave the galls, which are made at the edges of the leaves and which afford very good protection, and crawl out on the flat surfaces of the leaves where the old skins are left behind. These cast skins are commonly mistaken for the living forms. The bodies are covered with simple and spear-shaped spines (Fig. 23 C).

Adults (Pl. 20, fig. 4 and fig. 23).—The adults greatly resemble those of the tomato psyllid in general aspects. The bodies are pale amber with darker brownish or nearly black markings, as shown in the accompanying drawing (Fig. 23). On many of the individuals there is a noticeable narrow white line across the dorsal base of the abdomen; while in others this line is entirely absent. The legs and antennæ are pale yellow, with the last two joints of the antennæ black (Fig. 23 A, J). The length of the body averages about 2 mm.

Technical Description

Crawford gives the following technical description of the adults:

Length of body 1.9 mm.; length of forewing 3.2; width of head 0.71. General color greenish yellow to light brown; dorsum in darker individuals more or less striped and streaked with brown; abdomen often brown; antennæ black at tip.

Head nearly as broad as thorax, not strongly deflexed; vertex more than half as long as broad, emarginate in front at median line, with a prominent sulcate impression on each side of median line and parallel to it; genal cones scarcely two thirds as long as vertex, divergent, subacute, not much depressed from plane of vertex. Antennæ about one and a third times width of head, slender.

Thorax not broad, well arched, punctate; pronotum moderately long, not strongly depressed; præscutum rather large. Legs slender; hind tibiæ with two black spines at apex on inside and one outside. Wings long, slender, transparent, fully three times as long as broad, subacute at apex; Rs short.

Genitalia.—Male.—Anal valve a little longer than forceps, hind margin arcuate, with long pubescence; forceps rather stout, sides almost parallel (from side), terminating in a subacute, black point at apex. *Female.*—Genital segment nearly as long as rest of abdomen, acute at apex, valves subequal in length.[1]

[1] Crawford, D. L., Bul. 85, U. S. Nat. Mus., pp. 94–95, 1914.

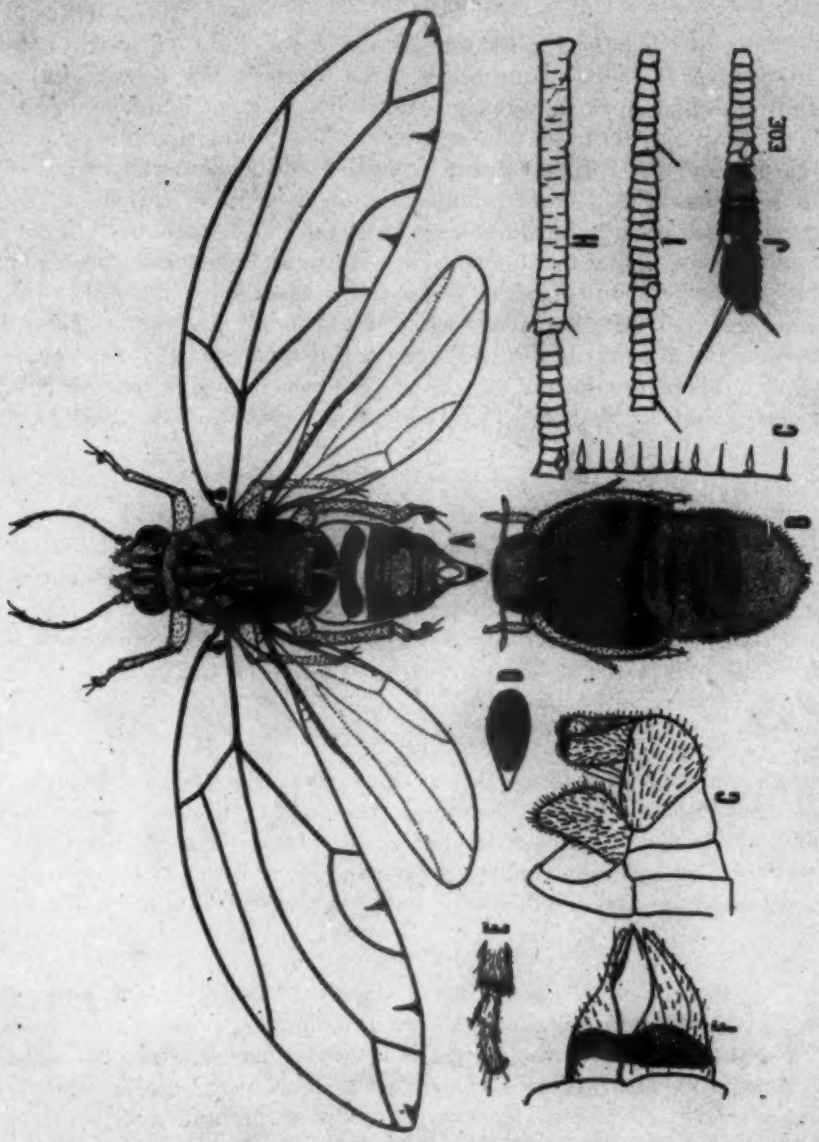

Fig. 23.—The laurel psyllid, *Trioza alacris* Flor. *A*, adult female with wings spread; *B*, nymph with cottony covering removed to show the body; *C*, simple and spear-shaped spines which cover the body of the nymph (greatly enlarged); *D*, egg; *E*, tip of tibia showing apical spines; *F*, genitalia of female; *G*, genitalia of male; *H*, third and fourth joints of the antenna; *I*, fifth, sixth and seventh joints of the antenna; *J*, eighth, ninth and tenth joints of the antenna. All much enlarged. (Original).

Life-History

The winter is passed in the adult stage in a more or less active condition upon the food plants or upon the plants in the near vicinity. In March and April the eggs are laid in few or great numbers on the very small leaves of the tender shoots. The young nymphs feed at the edges of the leaves, causing a decided curling and thickening of those places (Fig. 3) and producing quite a definite leaf-gall. The galls enlarge with the leaves and are at first of the same color, but gradually become lighter and later bright reddish and eventually brown or black. As previously stated, the nymphs usually remain within the galls until maturity is reached when the latter are deserted and often become the abode of other insects, especially mealy bugs (*Pseudococcus* spp.). There are several broods a year, the last one maturing in October and November. Two broods are reported in Europe.[1]

Distribution

The first specimens of this insect were collected in Oakland, Alameda County, and in San Mateo County by Mr. O. E. Bremner.[2] No other infestations were reported until October 1914 when Mr. C. J. Pearsons, a graduate student at the University of California, found it in a nursery at Niles, Alameda County. These are the only known records for California and the United States. In Europe the insect is quite generally distributed.

Food Plants

The only recorded food plant in this state is the laurel or sweet bay (*Laurus nobilis* Linn.). In Europe the insect attacks, besides the above, the cherry laurel or English laurel (*Prunus laurocerasus* Linn.) and the Canary laurel (*Laurus canariensis* W. & B.). As opportunity is afforded these trees will also probably become infested in California.

Control

The control of this pest is very difficult. Besides being covered with a thick waxy secretion which is resistant to sprays, the nymphs are also protected in the leaf-galls from ordinary control measures. The adults which are present practically the entire year are exceedingly active and fly away as soon as the infested plants are disturbed.

Fumigation readily kills all forms, but it is usually impossible to confine the adults under a tent or get them to a fumigating house. The nymphs and eggs, may however, be effectually killed in this way.

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[1] Sulc, Karel, Sitz. Kön. Böh. Ges. Wiss. Prag, pt. XVI, p. 51, 1912.

[2] Crawford, D. L., Mthly. Bul. Cal. Hort. Com., I, No. 3, p. 86, 1912, and Bul. 85, U. S. Nat. Mus., p. 95, 1914.

During the winter months when the adult stage only persists, the plants may be removed to a fumigating house or tent and fumigated and if immediately removed to a safe distance from all other points they may be kept free from reinfestation and shipped elsewhere if they remain clean after a few months' time.

Spraying with miscible oils and oil emulsions readily kills all stages if repeatedly and thoroughly applied. The manufactured grades of miscible oils and kerosene emulsion, crude oil emulsion, and crude carbolic acid emulsion may be used.[1]

Hand-picking has been resorted to in one nursery, but the results have not been satisfactory because of immediate reinfestation.

To get satisfactory results all infested plants must be segregated and removed from other plants to a perfectly clear place and the treatment applied to all as fast as possible and in a definite direction, beginning at one side or end. If the area is so large that it will require more than a few hours to make the treatment, the plants must be removed elsewhere as fast as treated or else they will become reinfested with the adults before the last ones are reached. This has been the fault of most of the work done so far.

Summary

1. Of some fifty described species only two psyllids may be considered of economic importance in California. They are the tomato psyllid, a native species and the laurel psyllid, imported from Europe.

2. The tomato psyllid is generally distributed throughout the state, and, while it prefers solanaceous food plants, also infests others.

3. The tomato psyllid may be controlled by spraying, but is only occasionally serious enough as a pest to warrant a treatment.

4. The laurel psyllid is a serious enemy of the laurel or sweet bay tree, causing disfigurations of the foliage, smutting and generally stunting the plants.

5. The distribution of the laurel psyllid is limited to a few localities in the San Francisco Bay region.

6. When the laurel psyllid is present it is necessary to employ control measures which consist in spraying or fumigation.

7. The laurel psyllid is of sufficient importance to warrant a con-

[1] For the formulæ and methods of preparing and using the above sprays see:

Woodworth, C. W., Circ. No. 128, Cal. Agrcl. Exp. Sta., pp. 3–5, April, 1915 (This circular may be had by applying to the Director of the Agricultural Experiment Station, Berkeley, Cal.).

Essig, E. O., Inj. Ben. Ins. Cal., 2d ed., Cal. Hort. Com., pp. 465–480, May, 1915 (This publication may be secured from the State Commissioner of Horticulture, Sacramento, Cal.).

siderable outlay in money for its eradication which is now possible because of its limited distribution.

(Berkeley, Cal., Jan. 1, 1916.)

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Essig, Inj. & Ben. Ins. Cal. 2nd. edit., pp. 68–70, 1915 (2 illustrations).
Thomas,[1] Gartenflora, XC, pts. 2 & 3.
Bohlin,[1] Ent. Tidskr., XXII, pp. 81–92 (1 figure).
Hieronymus,[1] Pax, Herbarium Cecidologicum fasc. VIII, No. 231.
Trioza lauri Targioni-Tozetti, Resocont. Soc. Ent. Ital., p. 19, 1879.

[1] As the dates could not be secured for these references, they are placed at the end.

Explanation of Plate 20

Fig. 1.—The tomato psyllid, *Paratrioza cockerelli* Sulc. Nymphs and their white pellet-like excrement on the underside of a tobacco leaf. Enlarged two and one half times. (Original. Photo by Dept. of Scientific Illustration, Cal. Agrcl. Exp. Sta.).

Fig. 3.—The laurel psyllid, *Trioza alacris* Flor. Leaf-galls on young shoot of laurel tree caused by the nymphs. The white cottony masses are the old skins of the nymphs. Natural size. (Author's illustration, Inj. Ben. Ins. Cal. 2nd. ed., 1914).

Fig. 4.—The laurel psyllid, *Trioza alacris* Flor. Adults, nymphs and the cast skins of the latter on a leaf of the laurel tree. Enlarged 6 times. (Author's illustration, Inj. Ben. Ins. Cal. 2nd. ed., 1914).

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Tomato Psyllid

Scientific Notes

The Pink cornworm (*Batrachedra rileyi* Wals.) has been discovered in injurious numbers in corn in several localities in Mississippi, and in less numbers in Louisiana and adjacent states.

Wanted: Coccinellid Parasites. A study is being made of *Epomphaloides minutus* How., a chalcidid parasite of Coccinellids, which so far has been reared by the writer only from species of the genus *Coccinella*. If field men will send definite records of the occurence of this parasite, or any other chalcidid parasites of Coccinellids, together with the name of the host, such information will be greatly appreciated. Parasitized material (the chalcidid parasitizes the larvæ and pupæ of the Coccinellids), or reared specimens of the parasites, in case these have not been determined, are also desired. Address: E. J. Newcomer, General Delivery, Portland, Oregon.

Studying the Eggs of Hemiptera. The older entomologists will recall the work undertaken by the late Mr. Otto Heidemann, relating to the study of the eggs of Hemiptera, which resulted in the admirable paper published by him in 1911. Since then practically nothing has been added to the knowledge of this subject. It is now proposed to take up and continue with this important phase of insect life where Mr. Heidemann left off. The attention of field men associated with the Bureau as well as other entomologists is called to this project in hopes that whenever the opportunity occurs they will send in the eggs of Hemiptera for study and description, Any material will be greatly appreciated, and should be addressed to Edmund H. Gibson, Division of Insects, U. S. National Museum, Washington, D. C.

Further Notes on Preservation of Insect Collections. In the December number of the *Monthly Letter* of the Bureau of Entomology appeared an interesting note from Mr. T. S. Wilson concerning the protection of the insect collections. At this station we have adopted Mr. T. S. Wilson's suggestion of melting naphthalene and pouring it into the lids of Schmidt boxes, finding it much more practicable than the use of naphthalene cones which frequently "go adrift" and do much damage to pinned specimens. At this Station we use for storage purposes great numbers of cigar boxes, and we find that the best method of preventing the ingress of any "museum pests" is to brush melted paraffin about corners and edges of boxes used for such purposes. We have successfully stored large quantities of entomological material and find that after fastening down the lid with a tack that the melted paraffin brushed about the corners of the boxes successfully protects the material.

WM. B. TURNER, *Hagerstown (Md.) Field Station*. Feb. 10, 1917.

Clover Leaf Weevil. The JOURNAL OF ECONOMIC ENTOMOLOGY for August, 1916' contained "Notes on the Distribution of the Clover-leaf Weevil (*Hypera punctata* Fab.) in Kansas" by Mr. James W. McColloch of the Kansas Agricultural Experiment Station. The writer can add that this species also occurs at Wellington, Kansas.

While carrying on an investigation of a certain insect in Wellington, Kansas, on July 30, 1915, the writer killed several toads to see if the insect under investigation constituted part of the toad's food. One of the toads' stomachs contained an adult (*Hypera punctata* Fab.). The beetle was sent to Washington and determined as this species and the toad was determined by the Biological Survey as *Bufo americanus*. These toads were caught in alfalfa field near Wellington, Kansas.

T. S. WILSON,
Scientific Assistant.

A Directory of Workers in Hemiptera. During February a circular letter and data blank was sent to all entomologists in this country known to be particularly interested in Hemiptera, the object being to get together a directory of workers within the order, listing their projects in hand and past publications. To date more than 30 blanks have returned with detailed data. If any field men connected with the Bureau, or otherwise, are at present engaged in any problem—economic, biologic, or systematic—relative to Hemiptera and have not received a blank to fill in, they will be conferring a favor by sending data under the following headings to Edmund H. Gibson, Divison of Insects, U. S. National Museum, (*a*) Name, (*b*) Address, (*c*) Position and institution affiliated with, (*d*) Character of work, (*e*) Problems in hand or expecting to undertake, (*f*) List of publications.

Monthly Letter, Bureau of Entomology, February, 1917.

The Mediterranean Flour Moth (*Ephestia kuehniella* Zell.). This insect has attracted more attention during 1916 than for several years. It has made its appearance in warehouses and mills where it was not formerly found. The list of localities includes mostly small towns and cities. It is interesting that while formerly when this species was so very abundant, nearly all millers knew the insect as the Mediterranean flour moth, at the present time they refer to it as "weevil," "flies," and infested material is seldom accompanied by other species of insects. One correspondent writes, "We are worried with a fly that lays eggs, apparently these hatch, and a worm gets in all elevators and spouts, causing a web which takes a very little time to fill cups and spouts, causing web in the flour, and interfering with the flow of the mill."

Hymenia perspectalis Hubner, a Greenhouse Pest. My good friend, Mr. William Falconer, the superintendent of the Allegheny Cemetery, Pittsburgh, on January 10, 1917, came to me, bringing with him a number of specimens of *Hymenia perspectalis* Hübner, and several potted plants of *Alternanthera* which showed the ravages of the larvæ of this little moth.

He reports to me that the insect has confined its attentions to the young plants of *Alternanthera*, which is extensively propagated in the green-house for use in the borders of parterres. Its work has been almost ruinous, and, as this is the first time he has ever seen the thing, he was naturally anxious to learn more about it. I have not taken the time to make a search of the recent literature of the subject to ascertain whether it has been recorded as a pest in other places, but simply call attention in these lines to the fact that, if allowed to propagate in green-houses and conservatories, it may do great damage to the above-mentioned plants.

W. J. Holland.

Carnegie Museum, Pittsburgh, January 25, 1917.

The Life-histories of the Cattle Lice. The life-histories of these species have been worked out during this winter. Ten specimens of the short-nosed ox louse (*Hæmatopinus eurysternus*) were placed on a restricted region on the shoulder of a Holstein calf that was less then twenty-four hours old. The white eggs were soon laid. These were observed once each day and the eggs hatched in from seven to eight days after they were laid. These young were removed and placed on another calf and these laid eggs in from fifteen to sixteen days after hatching, making a life-cycle of from twenty-two to twenty-four days. The female of this species lays from thirty-five to fifty eggs each. The life-history was checked on other calves.

The life-history of the long-nosed ox louse (*Hæmatopinus vituli* Linn.) was very similar though it was slightly longer. The method used was the same as in the previously mentioned louse. These insects were placed in a white patch where the shining black eggs hatched in from eight to nine days and the lice again laid eggs in from

seventeen to eighteen days after hatching, making a life-cycle of from twenty-five to twenty-seven days.

The little red biting lice (*Trichodectes scalaris* Nits) have been much harder to determine owing to the difficulty in keeping them confined. From the writer's observations supplemented by the hatching of eggs in an electric incubator it is believed that they hatch from the eggs in from five to six days and mature in two weeks though more work must be done on this species to determine its life-cycle with the accuracy of the two previously mentioned species. This would indicate that a treatment might be repeated with the best results from ten days to two weeks after the first treatment.

The experimental work on the control measures will appear in the future in a bulletin from the Storrs Experiment Station.

G. H. Lamson, Jr.,
Storrs, Conn.

An Infestation of Lasius niger L. var. americana with Laboulbenia formicarum Thaxter. On April 7 the writer collected a number of ants of the species *Lasius niger* L. var. *americana*. Upon close examination under a binocular microscope fungus growths were observed on the ants. The fungus occurred particularly on the posterior part of the head, the dorsal surface of the abdomen, and the femora and tibiæ. Every worker examined from one colony was affected, some having more hyphal outgrowths than others. The fungus was identified by Professor R. F. Griggs of Ohio State University as *Laboulbenia formicarum* Thaxter. The fungus apparently had no injurious effects upon the ants, which were as lively as those not parasitized, and the organism is of interest because of its rareness rather than through its effect upon the host. The writer examined the ants of several adjoining colonies but found the individuals of only one other colony infested. This colony was about fifteen feet from the original colony and may have been connected with the former by means of subterranean galleries. Dr. Thaxter of Harvard University has made an interesting study of this and other Laboulbenia, all of which affect insects exclusively.

M. R. Smith,
Department of Entomology and Zoölogy, Ohio State University.

Credit to Whom Credit is Due. On a recent visit to the Bureau of Entomology, through the courtesy of Dr. L. O. Howard the following facts were ascertained:

The anonymous person mentioned by C. V. Riley in his article on the Ox Bot of the United States 1892, was Mr. F. G. Schaupp of Shovel Mount, Texas, a special field agent of the U. S. Department of Agriculture. Dr. Howard kindly showed me a number of letters from Mr. Schaupp dated March, 1892, proving conclusively that he was the experimentor and that Riley merely recorded his observations. The anonymity of that time was on account of personal matters relating to Mr. Schaupp. The principal reason for my writing this note is on account of a somewhat severe criticism I made of the late Professor Riley in Parasitology, 1915, saying that his records were not his own, and also to give credit to Mr. Schaupp for his excellent and valuable experiments on the life-history of *H. lineatum*. Seeing that Professor Riley is dead and that Mr. Schaupp was buried at San Antonio on November 10, 1903, there seems to be no further necessity for keeping his name secret. Mr. Schaupp was the first president of the Brooklyn Entomological Society and is well known for his work in Entomology, especially on the Coleoptera. In conclusion it might be mentioned that Mr. Schaupp was the first discoverer of the eggs of *H. lineatum* and that he also made some valuable notes on the method of oviposition; therefore I think that in future his name should be mentioned in all articles relating to past experiments on Warble-flies.

Seymour Hadwen,
Agassiz, B. C.

Megastigmus aculeatus Swed., Introduced into New Jersey from Japan. (Hymen.) At different times during the past few years, rose growers have complained somewhat, of the failure of Japanese *Rosa multiflora* seeds to germinate. Upon collecting samples of the seeds and keeping them under observation, it was found that they were heavily infested by a member of the *Torymidæ*, which was later identified by Mr. Girault through the courtesy of Dr. L. O. Howard as *Megastigmus aculeatus* Swed. The larvæ of this genus are known to live in the seeds of plants and C. R. Crosby in "A Revision of the North American Species of Megastigmus" (An. Ent. Soc. Amer., vol. 6, No. 2, pp. 155–170, June, 1913) states that this species was reared from rose seeds at Ithaca, N. Y., and that in the collection of the U. S. National Museum, there is a series of specimens reared from rose seeds imported from Peking, China. He also reared specimens from rose hips received from Germany. In order to determine definitely if the species was being imported into New Jersey from Japan, samples of *Rosa multiflora* seeds were taken from nearly every shipment consigned to the State during the spring of 1917. After keeping them nearly fifty days, parasites emerged from all of them about the latter part of May. The larva appears to destroy the entire interior of the seed leaving nothing but the hard outer covering.

HARRY B. WEISS,
New Brunswick, N. J.

Migration of Danaus archippus. Miss Joanna Carey writes from La Junta, Colorado, that on April 26 a "cloud of butterflies" arrived at that place, at about 5.30 in the evening. They seemed to be carried before a very hard wind which was blowing from the east or northeast. Great numbers were to be seen later on the grass, trees and sidewalks. Two specimens sent are both males.

T. D. A. COCKERELL.

A Correction. Line 25, page 260, vol. 10, No. 2, Journal of Economic Entomology, should read "larvæ of the three probable parasites" instead of "larvae of the three parasites probably."

WM. P. HAYES.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

AUGUST, 1917

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. Photoengraving may be obtained by authors at cost. The receipt of all papers will be acknowledged.—Eds.

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Applied or practical entomology is so obviously that phase of entomology which is useful or of immediate value that further definition appears unnecessary. Numerous efforts being made to conserve and increase the food supply and natural resources of the nation lead us to question seriously whether our entomology is sufficiently practical to measure up to the present needs of the day. There have been during the last few months various efforts to bring the practical applications of entomology more closely home to the fruit grower and the farmer. The letter, the circular, and the printed sheet have been used freely, and yet it is probable that some of the most effective work has been accomplished through county or other local agents with more or less of an official standing. The county agent has served as both the eye and the interpreter for the entomologist, reporting upon developments in the field, and personally explaining and supervising preventive and control measures. The right man in the field can undoubtedly accomplish much in bringing about a better handling of the insect problem, since most farmers are much more favorably inclined toward a tactful discussion and demonstration than a more or less lengthy letter or bulletin giving directions for procedure.

The value of this work must depend in large measure upon the possibility of anticipating insect injury. The first year under such a system cannot begin to be as successful as later ones because it is very difficult, in fact almost impossible, to anticipate local developments without some previous experience. Moreover, the significant features,

entomologically speaking, of one season differ from those of another, and it is only through careful study extending over a series of years that the scientist and the field worker can coöperate in a highly efficient method of reporting and disseminating information, involving, as this does, discrimination between the vital and the comparatively unimportant, and the forecasting of developments. The present season has demonstrated more fully, perhaps, than any other during the last twenty-five years the profound influence which seasonal conditions may have upon certain insects. These modifications can be forecast in only a general way and are bound to be changed within comparatively narrow limits by local variations.

Current Notes

Conducted by the Associate Editor

Mr. Frederick Knab has been elected a fellow of the Entomological Society of America.

Miss Ina L. Hawes, S. B. Simmons College, 1917, has been appointed assistant in the library of the Bureau of Entomology.

Mr. E. C. Cotton, Elyria, Ohio, has been appointed Chief of the Bureau of Horticulture of the Ohio Department of Agriculture.

On June 5, Dr. A. L. Quaintance and Mr. E. H. Siegler of the Bureau of Entomology visited the Connecticut Agricultural Experiment Station, New Haven, Conn.

The Bureau of Entomology has received word that the Zoölogical Record, Regent's Park, London, N. W., England, has temporarily suspended publication, owing to the war.

Mr. Arthur Gibson, Assistant Dominion Entomologist of Canada, and Mr. E. M. Schalck, Assistant to the State Entomologist of Illinois, recently visited the West Lafayette, Ind., Field Station of the Bureau of Entomology.

Mr. B. A. Porter, a graduate of the Massachusetts Agricultural College, has been appointed to assist R. A. Cushman in the study of hymenopterous parasites of deciduous fruit insects and will be stationed at Wallingford, Conn.

The last legislature of Connecticut increased the appropriation for general work against insect pests from $8,000 to $12,000, and for gipsy and brown-tail moth suppression work from $21,000 to $40,000 for the next biennium.

According to *Science*, Professor D. L. Crawford of Pomona College, Claremont, Calif., has been appointed Professor of Entomology in the College of Hawaii, Honolulu, H. I., for a period of three years, beginning in September 1917.

On June 6, Dr. L. O. Howard, Washington, D. C., Dr. T. J. Headlee, New Brunswick, N. J., and Dr. W. E. Britton, New Haven, Conn., attended a meeting of the National Malaria Committee at the Hotel Biltmore in New York City.

A new division has recently been created in the Bureau of Animal Industry of U. S. Department of Agriculture, to be known as The Tick Eradication Division, and devoted exclusively to the work of eradicating the cattle fever tick in the South.

Dr. E. A. Back, of the Bureau of Entomology, has been placed in charge of the new section of Stored-Product Insect Investigations, recently organised in the Bureau. He spent June 15–16 visiting the Department of Entomology of the Kansas Experiment Station.

Mr. Louis A. Stearns, graduate of Ohio Wesleyan University and Ohio State University, has been appointed for temporary work on insects as carriers of disease in coöperation with the H. J. Heinz Company and the Bureau of Plant Industry at Madison, Wis.

The section on Deciduous Fruit Insect Investigations of the Bureau of Entomology has recently established a field station in Wallingford, Conn., and will take up the study of the tent caterpillar, the apple maggot, and certain other fruit insects. Mr. E. H. Siegler is in charge.

The following transfers have been made recently in the Bureau of Entomology: G. A. Runner from Southern Field Crop Investigations to Deciduous Fruit Insect Investigations, with headquarters at Sandusky, Ohio; A. B. Champlain, Lyme, Conn. to Falls Church, Va.; E. H. Siegler, Washington, D. C., to Wallingford, Conn.

J. D. Mitchell of the Bureau of Entomology has begun an investigation of two rice insects which have caused very large losses in Matagorda County, Tex. Both species are new as enemies of rice. Together they have destroyed the greater part of forty thousand acres of rice, and threaten to spread extensively during the coming season.

On June 6, W. Dwight Pierce received the degree of Doctor of Philosophy from the George Washington University, Washington, D. C. The title of his thesis was "Comparative Morphology of the Insect Order Strepsiptera." The minors were "The Relation of Insects to Disease," and "The Relation of Climate to Insect Life and Activity."

Dr. A. G. Boving and F. C. Craighead, of the Bureau of Entomology, are very anxious to secure living adults of *Corydalis* for anatomical purposes. It will be appreciated if any one who finds adults of the "Dobson fly" will send them alive (in small tin can) to either Dr. Boving at U. S. National Museum or Mr. Craighead at East Falls Church, Va.

A series of meetings of beekeepers were held early in July at points in Vermont under the supervision of Dr. Burton N. Gates, now a Collaborator of the Bureau of Entomology. A similar series of meetings is being arranged in western Maryland which will be attended by Kenneth Hawkins and G. H. Cale of the Maryland State College of Agriculture, now Collaborator of the Bureau.

According to *Science*, Messrs. George P. Englehardt, Curator of Invertebrates, and Jacob Doll, Curator of Lepidoptera in the Brooklyn Museum, have, through the generosity of Mr. B. Preston Clark of Boston, undertaken an expedition to the plateau regions of southwestern Utah and Northern Arizona, and will give particular attention to lepidoptera, small mammals and reptiles.

One of the salient features of the initial number of the Emergency Entomological Service issued May 1, is covered under the title "Bioclimatic Law as Applied to the Hessian Fly," by A. D. Hopkins, Forest Entomologist, and is the first direct effort in the application of phenological data to insect emergence and crop planting. (Inquiries and suggestions should be addressed to Dr. A. D. Hopkins, Forest Entomologist, Bureau of Entomology.)

Subscriptions are being received from the employees of the U. S. Department of Agriculture for a fund of $1,450 to be used in donating a fully equipped Red Cross ambulance for use in Europe. This gives a very definite means for aiding in the important work of the Red Cross. The ambulance will be known officially as the United States Department of Agriculture Ambulance. Subscriptions should be sent to Mrs. H. S. Bishop of the Bureau of Entomology.

The following have recently been appointed to the Bureau of Entomology: E. L. Sechrist, Fairoaks, Calif., Assistant in Apiculture, Drummond, Va.; G. N. Wolcott, special field assistant, sugar cane insects, Louisiana and Texas; Torbert Stack, Tallulah, La., K. B. McKinney, A. D. Bosley and F. G. Sorrells, Clarksville, Tenn., temporary field assistants; H. J. Hart, Falls City, Neb.; Dr. Burton N. Gates, Amherst, Mass., and G. A. Gale, College Park, Md., Collaborators; Miss M. A. MacNab, Clerk, Falls Church, Va.

Prof. A. C. Burrill resigned last summer from the position of Assistant Entomologist of the Wisconsin Experiment Station and Instructor in Economic Entomology in the Agricultural College to become Entomologist of the Idaho Experiment Station and Assistant Professor in the Zoölogy and Entomology Department of the University of Idaho. This summer Professor Burrill is in charge of the new substation for entomological work, especially clover aphis, at Twin Falls, Idaho, the heart of the irrigated empire of the Snake River plains.

The following were visitors to the Bureau of Entomology during May: Dr. Burton N. Gates, Massachusetts Agricultural College, Amherst, Mass.; A. F. Burgess, In Charge of Moth Work, Melrose Highlands, Mass.; W. M. Mann, of Bussey Institution, Forest Hills, Mass.; Fred Muir, Assistant Entomologist of the Hawaiian Sugar Planters' Experiment Station, Honolulu, Hawaii; D. M. Rogers, Gipsy Moth Investigations, Boston, Mass.; W. F. Fiske, late of the Bureau of Entomology, who has recently returned from the British service in Africa.

Charles Fuller Baker, A. M., Professor of Agronomy, College of Agriculture, University of the Philippines (stationed at Los Banos, Philippine Islands), announces that he is taking a year's leave of absence, and that for this year he has accepted, under temporary appointment, the post of Assistant Director of the Botanical Gardens at Singapore, in charge of experimental work in Tropical Agronomy. After May 12, 1917, and until further notice, all correspondence should be addressed to him, care of Botanical Gardens, Singapore, Straits Settlements.

August Busck, of the Bureau of Entomology, has returned from his trip to Mexico where he made a careful examination of cotton fields on both sides of the Mexican border in the Brownsville-Matamoros region without finding any evidence of the pink bollworm. Neither was any evidence of infestation found in the district opposite Eagle Pass, Tex., but two Mexican plantations near the United States were found on which considerable areas of cotton had been planted with seeds imported from the Laguna district. There is every reason to anticipate, therefore, that in these fields the pink bollworm will develop this year. A very strict watch must be maintained, and whatever remedial steps are possible will be undertaken in coöperation with the Mexican authorities.

Mailed August 20, 1917.